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NATIONAL DAM SAFETY PROGRAM. LAKE ESTLING DAM (NJ 00184), PASSA--ETC(U)
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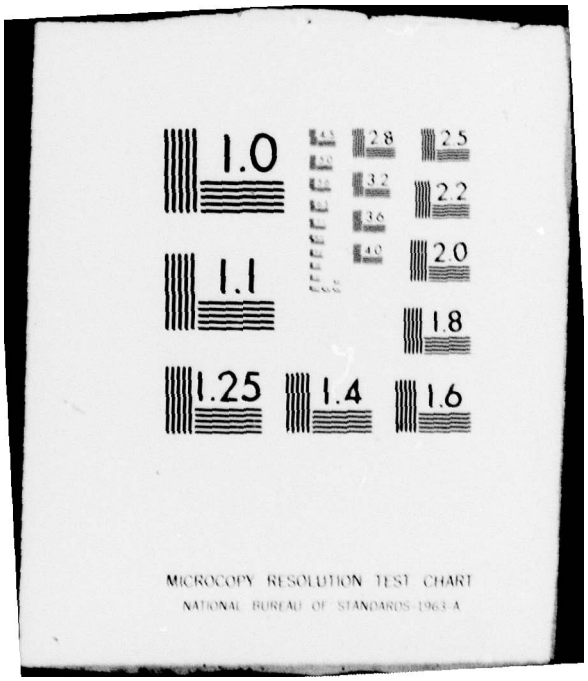
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PASSAIC RIVER BASIN
DEN BROOK, MORRIS COUNTY
NEW JERSEY

LEVEL II

LAKE ESTLING DAM

NJ 00184

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

August, 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): Phase I Inspection Report
National Dam Safety Program
Lake Estling Dam
Morris County, N.J.

5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL rept.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): (10) Warren A. Guinan
Guinan, Warren P.E.

8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-79-C-0011

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Anderson-Nichols
6 Louden Rd.
Concord, NH 03301

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS:
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Custom House, 2d & Chestnut Streets
Philadelphia, Pennsylvania 19106

(11) Aug 79

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15. SECURITY CLASS. (of this report): Unclassified

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16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) National Dam Safety Program. Lake Estling Dam (NJ 00184), Passaic River Basin, Den Brook, Morris County, New Jersey. Phase 1 Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Lake Estling Dam, N.J.
Spillways
Slopes
Seepage
National Dam Safety Act Report
Structural Analysis
Visual inspection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

17 SEP 1979 1st.

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Lake Estling Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Lake Estling Dam, a high hazard potential structure, is judged to be in fair overall condition. The spillway is considered seriously inadequate since forty percent of the Probable Maximum Flood (PMF) would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard of loss of life downstream from the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to:

(1) Investigate the seepage at the downstream toe, and design appropriate remedial measures.

(2) Design and supervise a program for clearing trees and brush from the upstream and downstream slopes of the dam.

(3) Investigate the location and condition of the low level outlet pipes and valves and, if necessary, design procedures to restore them to an operable condition.

(4) Design repairs and slope protection for the areas where erosion has occurred on the upstream and downstream slopes of the dam.

(5) Design repairs for the abutments of the spillway to stop the leakage and to restore the stone masonry to good structural condition. Any remedial actions should be completed within three months from the date of approval of this report.

c. Within 30 days from the date of approval of this report, a program should be initiated to periodically check the condition of the dam and monitor the seepage until remedial measures are effected.

d. Within three months from the date of approval of this report, a program should be initiated to control trespassing on the upstream and downstream slopes of the dam.

e. Within one year from the date of approval of this report, engage a professional engineer experienced in the design and construction of dams to make a comprehensive technical inspection of the dam once every two years.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James A. Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

LAKE ESTLING DAM (NJ00184)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 16 May 1979 by Anderson-Nichols and Co., Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Lake Estling Dam, a high hazard potential structure, is judged to be in fair overall condition. The spillway is considered seriously inadequate since forty percent of the Probable Maximum Flood (PMF) would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard of loss of life downstream from the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to:

(1) Investigate the seepage at the downstream toe, and design appropriate remedial measures.

(2) Design and supervise a program for clearing trees and brush from the upstream and downstream slopes of the dam.

(3) Investigate the location and condition of the low level outlet pipes and valves and, if necessary, design procedures to restore them to an operable condition.

(4) Design repairs and slope protection for the areas where erosion has occurred on the upstream and downstream slopes of the dam.

(5) Design repairs for the abutments of the spillway to stop the leakage and to restore the stone masonry to good structural condition. Any remedial actions should be completed within three months from the date of approval of this report.

c. Within 30 days from the date of approval of this report, a program should be initiated to periodically check the condition of the dam and monitor the seepage until remedial measures are effected.

d. Within three months from the date of approval of this report, a program should be initiated to control trespassing on the upstream and downstream slopes of the dam.

e. Within one year from the date of approval of this report, engage a professional engineer experienced in the design and construction of dams to make a comprehensive technical inspection of the dam once every two years.

APPROVED: Joel T. Callahan LTC
JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

DATE: 13 September 1979

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

7 SEP 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

This is in reference to our ongoing National Program for Inspection of Non-Federal Dams with the State of New Jersey. Lake Estling Dam (Federal I.D. No. NJ00184), a high hazard potential structure has recently been inspected. The dam's embankment is owned by the New Jersey Department of Transportation and the spillway is owned by Estling Lake Corporation and is located on Den Brook approximately six miles upstream from Mount Hope.

Using Corps of Engineers screening criteria, it has been determined that the dam's spillway is seriously inadequate since approximately 40 percent of the Probable Maximum Flood would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise, or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE unclassification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam could take place, significantly increasing the hazard potential to loss of life downstream from the dam. As a result of this UNSAFE determination, it is recommended that the dam's owner take the following measures within 30 days of the date of this letter:

a. Engage the services of a qualified professional consultant to more accurately determine the spillway adequacy by using more detailed and sophisticated hydrologic and hydraulic analyses, and to recommend any remedial measures required to prevent overtopping of the dam.

b. In the interim, a detailed emergency operation plan and downstream warning system should be developed. Also, round-the-clock surveillance should be provided during periods of unusally heavy precipitation.

A final report on this Phase I Inspection will be forwarded to you within two months.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies Furnished:
Dirk C. Hofman, Actg. Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

UNSAFE DAM
NATIONAL PROGRAM OF INSPECTION OF DAMS

a. NAME: Lake Estling Dam

b. ID NO.: NJ00184

c. LOCATION State: New Jersey County: Morris.
River or Stream: Den Brook.
Nearest D/S City or Town: Mount Hope

d. HEIGHT: 19 feet.

e. MAXIMUM IMPOUNDMENT CAPACITY: 1341 ac ft.

f. TYPE: Earthfill with timber core wall.

g. OWNER: NJDOT & Estling Lake Corporation.

h. DATE GOVERNOR NOTIFIED OF UNSAFE CONDITIONS: 7 Sep 79

i. CONDITION OF DAM RESULTING IN UNSAFE ASSESSMENT Preliminary report calculations indicate 40% of PMF would overtop the dam.

l. URGENCY CATEGORY: UNSAFE, Non-Emergency.

m. EMERGENCY ACTIONS TAKEN:
Gov. notified of this condition by District Engineer's letter of 7 Sep 79.

j. DESCRIPTION OF DANGER INVOLVED:
Overtopping and failure of the dam would significantly increase hazard potential to loss of life and property downstream of dam.

h. REMEDIAL ACTIONS TAKEN:
N.J.D.E.P. will notify dam's owner upon receipt of our letter.

k. RECOMMENDATIONS GIVEN TO GOVERNOR:
Within 30 days of date of District Engineer letter the owner to do the following:
a. Engage the services of a qualified professional consultant to more accurately determine the spillway adequacy by using more detailed and sophisticated hydrologic and hydraulic analyses, and to recommend any remedial measures required to prevent overtoppoing of the dam.
b. In the interim, a detailed emergency operation plan and downstream warning sustem should be developed. Also, around-the-clock surveillance should be provided during periods of unusually heavy precipitation.

o. REMARKS: Final report, to be issued within six weeks, will have WHITE cover.

W. H. ZINK, Coordinator
Dam Inspection Program
U.S.A.E.D., Philadelphia

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Lake Estling Dam
ID Number:	FED ID No. NJ00184
State Located:	New Jersey
County Located:	Morris
Stream:	Den Brook
River Basin:	Passaic
Date of Inspection:	May 16, 1979

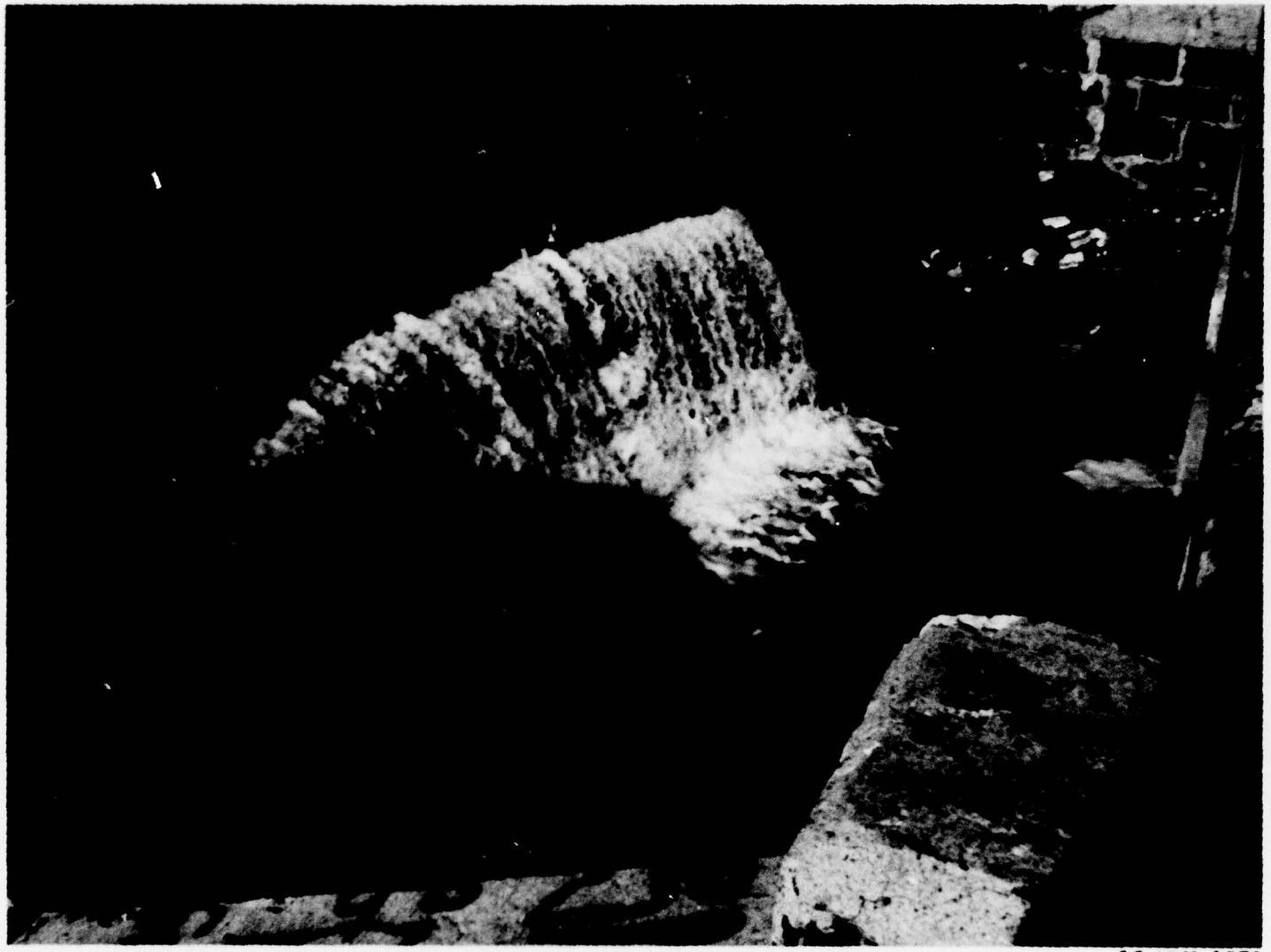
ASSESSMENT OF GENERAL CONDITIONS

Lake Estling Dam is 84 years old and in fair overall condition. It is intermediate in size and is classified as High Hazard. The dam is a railroad embankment and carries regular train traffic. Seepage and wet spots were observed at the toe of the dam from the west abutment to the spillway and from the spillway to the east abutment. Considerable trespassing and erosion were noted on both the upstream and downstream slopes of the embankment in the area of the spillway. The crest of the cut stone masonry weir is in fair condition. The spillway abutments are mortared stone masonry and the mortar is cracked and spalling on the vertical face. Mortar in the joints near the spillway, where in contact with water, has been completely eroded away. Leakage of 30 gpm was noted through each spillway abutment. The railroad culvert downstream of the spillway is the hydraulic control at high flows. It can pass less than 40% of the PMF and is seriously inadequate.

It is recommended that the owners retain the services of a professional engineer, qualified in the design and construction of dams, to accomplish the following tasks in the time frames specified. Starting immediately, further evaluate the hydrology and hydraulics of the watershed, reservoir, dam, spillway and railroad culvert; and determine, design, and implement mitigating measures necessary to provide for safe passage of high discharges. Also starting immediately, conduct a detailed investigation of embankment seepage and, design and implement appropriate seepage control measures. In the near future, specify and implement procedures for removing trees, their root systems, and brush from the upstream and downstream slopes of the embankment. Starting soon, investigate the location and condition of the low level outlet pipes and valves and, if necessary, design and implement measures to restore them

to an operable condition. Starting very soon, specify and implement measures to repair erosion on the embankment slopes and provide appropriate slope protection. In the near future, design and implement repairs to the mortared stone masonry spillway abutments. In addition, as a part of operating and maintenance procedures, it is recommended that the owners: starting soon, control the trespassing on the slopes of the embankment; starting immediately, check the condition of the dam periodically and monitor the seepage until remedial measures are effected; in the future, engage a professional engineer, qualified in the design and construction of dams, to conduct a technical inspection of the dam once every two years; and, in the near future, establish a surveillance program for use during and immediately following periods of heavy rainfall and also a warning program to follow in case of floodflow conditions or imminent dam failure.

Warren A. Guinan
Project Manager
New Jersey No. 16848



16 MAY 1979

OVERVIEW

LAKE ESTLING DAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY REPORT

LAKE ESTLING DAM, N.J. NO. 34 FED ID NO. NJ00184

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION PROGRAM
LAKE ESTLING DAM

US #NJ00184 NJ#34

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Authority to perform the Phase I Safety Inspection of Lake Estling Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 4 April 1979 under Contract FPM No. 39, dated 28 June 1979. This authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineers District, Philadelphia. The inspection discussed herein was performed by Anderson-Nichols & Company, Inc. on 16 May 1979.

b. Purpose. The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to safety of Lake Estling Dam and appurtenances based upon available data and visual inspection, and, determine any need for emergency measures and conclude if additional studies, investigations, and analyses are necessary and warranted.

1.2 Project Description

a. Description of Dam and Appurtenances. Lake Estling Dam is a 19-foot high, 1200-foot long earthfill railroad embankment dam, built around 1895. The upstream and downstream faces are of earth and rock ballast with a 2H:1V slope. The 34-foot long free overflow, curved, stepped, cascading spillway is near the center of the dam. The spillway is of cut masonry blocks and drops in 14" steps. The railroad embankment toe width averages 58 feet. Fifteen feet downstream of the spillway, the outlet channel passes through the railroad embankment in a 26 foot wide x 13 foot high box culvert. Downstream of the culvert, the channel exits into Indian Lake. Essential features of the dam are given in Figure 2.

b. Location. The dam is located in Morris County, New Jersey on Den Brook, a tributary to the Rockaway River, approximately 1 mile southwest of Denville Township, New Jersey. It is at north latitude 40° 53.0' and west longitude 74° 29.5'. A location map is given in Figure 1.

c. Size Classification. Lake Estling Dam is classified as being intermediate in size on the basis of storage at the dam crest of 1341 acre-feet, which is greater than 1000 acre-feet and less than 50,000 acre-feet, according to criteria given in the Recommended Guidelines for Safety Inspection of Dams. A height of 19 feet would place the dam in the small size category, however the intermediate classification, based on storage, prevails.

d. Hazard Classification. Visual inspection of the downstream area shows that breach of the Lake Estling Dam could possibly cause damages to 10 or more residences located immediately downstream of the embankment and the potential for loss of 30 or more lives. Accordingly, Lake Estling Dam is classified as High Hazard.

e. Ownership. The dam is a railroad embankment and is owned by the State of New Jersey, Department of Transportation, Trenton, New Jersey. The spillway is owned by Estling Lake Corporation, Denville Township, New Jersey. Contact with the Estling Lake Corporation was established through their lawyer, Donald Malehorne, of Wiley, Malehorne and Sirota, 250 Madison Avenue, Morristown, New Jersey.

f. Purpose of Dam. The lake is used for recreation.

g. Design and Construction History. A copy of the original spillway design plans dated 14 June 1895 was examined. These plans indicate that the spillway was not paid for by the railroad company. However the railroad did furnish the plans of the spillway to the builder, Estling Lake Ice Company, to ensure a satisfactory design. The masonry for the spillway and abutments was built during the period July to September 1895.

1.3 Pertinent Data

a. Drainage Area

6.44 square miles

b. Discharge at Damsite (cfs)

Maximum flood at damsite - unknown

Low level outlet at pool elevation (if operable) - 107

Total ungated spillway capacity at maximum pool elevation - 5105

c. Elevation (ft. above MSL)

Top Dam - 527.0

Design surcharge (PMF) - 528.3

Recreation pool (at time of inspection) - 516.9

Spillway crest - 516.7

Streambed at centerline of dam - 508.8

Maximum tailwater (estimated) - 520.0 (downstream of culvert)

d. Reservoir (feet)

Length of maximum pool - 3500

Length of recreation pool - 3400

e. Storage (acre-feet)

Recreation pool - 358

Design surcharge (PMF) - 1500

Top of dam - 1341

f. Reservoir Surface (acres)

Top dam - 89

Spillway crest - 75

g. Dam

Type - earthfill railroad embankment

Length - 1200^{+} feet

Height - 19 feet

Top Width - 58 feet

Side Slopes - upstream 2H:1V, downstream 2H:1V

Zoning - unknown

Impervious core - unknown

Cutoff - unknown

Grout curtain - unknown

h. Spillway

Type - free overflow curved, stepped (cascading)

Length of weir - 34'

Crest elevation - 516.7' MSL

Gates - none

U/S Channel - Lake Estling

D/S Channel - Culvert through railroad embankment to Indian Lake

i. Regulating Outlets

2 - 24" low level outlets are shown on original design plans.

2 - strainer boxes shown on original design plans. No strainer boxes were observed in field inspection.

No valving mechanism was observed in field inspection.

Owner stated bronze gate valves exist.

SECTION 2

ENGINEERING DATA

2.1 Design

No original design data for the dam embankment were disclosed. Copies of the original design plans for the spillway are kept by the current owner. They show a cut stone, curved, stepped, stone masonry spillway, as described in Section 1.2, set on a hemlock timber framework. Two 24-inch low level outlet pipes are shown to exit near the bottom of the spillway abutment walls. Plans for the spillway were apparently furnished by the railroad.

2.2 Construction

No construction data pertinent to the dam embankment were disclosed. The spillway was constructed between July and September 1895. Persons responsible for the construction are unknown.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. A search of the New Jersey Department of Environmental Protection files, contact with community officials and contact with the owners revealed only a limited amount of recorded information. A set of original design plans for the spillway dated 14 June 1895 were examined. These plans are owned by the Lake Estling Corporation and were not released for inclusion in this report.

b. Adequacy. Because of the limited amount of recorded data available, evaluation of this dam was based primarily on visual observations.

c. Validity. The recorded data retrieved were found to be in general agreement with visual observations; however, no outlets were observed for the two 24-inch pipes.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. Dam. Significant seepage at the downstream toe of the dam from the east abutment to the spillway, and from the spillway part way to the west abutment, was observed. Heavy brush and small trees are growing on both the upstream slope and downstream slope of the embankment. Trespassing and erosion are common at many locations on the upstream slope, at a few locations on the downstream slope, and next to the downstream wingwalls of the culvert under the railroad at the spillway. No unusual settlement or bulging of the embankment slopes was noted.

b. Appurtenant Structures. Leakage estimated at about 30 gpm was discharging from the third, fourth, and fifth joints from the top of each stone masonry abutment of the spillway weir. The mortar in the top joints of the abutments of the weir was spalled, cracked, and deteriorated, and the mortar in the joints closest to the spillway has eroded completely where it is in contact with the overflowing water. The upstream face of the railroad culvert above the spillway discharge channel has numerous cracks and spalled areas.

c. Reservoir Area. The watershed above the reservoir is gently sloping and heavily wooded. The shore of the reservoir has no steep, high slopes. No evidence of significant sedimentation was observed.

d. Downstream Channel. The channel downstream of the spillway weir passes under a railroad culvert and empties directly into Indian Lake which is at the downstream toe of the dam.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No formal operating procedures were disclosed.

4.2 Maintenance of Dam

No formal maintenance procedures for the dam were disclosed.

4.3 Maintenance of Operating Facilities

No formal maintenance procedures for the operating facilities were disclosed.

4.4 Warning System

No description of any warning system was disclosed.

4.5 Evaluation of Operational Adequacy

Because of the lack of operation and maintenance procedures the remedial measures described in Section 7.2 c. should be implemented as prescribed.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. Design Data. A copy of the original design plans for the spillway dated 14 June 1895 was examined. These design plans consist of five sheets, the plans show: (1) a plan view of the spillway, (2) timber mat framework on which the spillway rests, (3) sections through the center of the spillway and through the spillway abutment, (4) the strainer box through which the drawdown pipes flow, and (5) front and back elevations of the spillway. The entire spillway is founded on a mat framework of 8" x 12" and 12" x 12" hemlock timbers. The plan shows two drawdown pipes; one through each abutment. They are 24" pipes of unknown material, with no control mechanism indicated. These pipes are set 12' below the spillway crest upstream and have an exit invert at the downstream toe of the spillway. No visual indications of these pipes were noted. No other plans hydraulic/hydrologic data were disclosed.

b. Experience Data. Data received through conversation with Richard Price, President, Lake Estling Corporation, indicated that in the 25 years he has lived near Lake Estling, he has never seen the railroad embankment overtopped. No other experience data were disclosed.

c. Visual Observations. No visual evidence was found of damage to the structure caused by overtopping. At the time of inspection, approximately 0.2 foot of water was flowing over the spillway crest.

d. Overtopping Potential. The hydraulic/hydrologic evaluation for Lake Estling Dam is based on a spillway design flood (SDF) equal to the probable maximum flood (PMF) in accordance with evaluation guidelines for dams classified as high hazard and intermediate in size. The PMF has been determined by application of the SCS dimensionless unit hydrograph procedure to the 48-hour PMP Storm of 25.6 inches. Hydrologic computations are given in Appendix 3. The routed PMF discharge for the subject watershed is 15,473 cfs. The minimum elevation of the dam allows 10.3 feet of depth in the spillway before the overtopping occurs. Under this head the capacity of the railroad culvert through the dam is 5,105 which is less than the required SDF.

Flood routing calculations indicate that Lake Estling Dam will be overtopped for more than 4 hours to a maximum depth of 1.3 feet under PMF conditions. It is estimated that the culvert beneath the railroad embankment can pass approximately 38 percent of the PMF without causing dam overtopping.

The close proximity of downstream residences, which are below the elevation of the dam and upstream reservoir, could create an extremely hazardous situation should the embankment breach. The breach analysis, contained in Appendix III, indicates that the discharge increase from a non-breach to a breach situation is 15,584 cfs to 18,431 cfs under the PMF conditions. Under half-PMF conditions the breach discharge could be almost twice the non-breach discharge. Because a large portion of the discharge would be passing through the breach opening, this structure clearly meets all the requirements necessary to be classified as Seriously Inadequate. There is a high potential for loss of life. Failure would significantly increase the potential for loss of life downstream from that just before overtopping failure. The spillway cannot pass 50 percent of the PMF without dam overtopping.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Seepage at the downstream toe of the dam, if not corrected, could lead to future instability of the dam. If trees on the upstream and downstream slopes of the dam blow over and their roots pull out, or if a tree dies and its roots rot, serious seepage and erosion problems could result. Some of the brush now growing on the dam may attain tree size and could result in the same problems. Trespassing and erosion on the upstream and downstream slopes of the dam will seriously reduce the stability of the dam if not controlled. Deterioration of the mortar and leakage through the stone masonry abutments of the spillway will reduce the stability of the spillway abutments if not controlled. Deterioration of the railroad bridge over the spillway discharge channel will reduce the stability of the bridge if not remedied. Based on the visual inspection alone it is not possible to determine the character of the dam foundation or the interior of the cross section. Therefore, it is not possible to evaluate the factor of safety of the dam against slope failure.

b. Design and Construction Data. Design plans, dated 1895, show that the spillway is set on a mat of 6" x 12" and 12" x 12" hemlock timbers. No design plans for the embankment were disclosed.

c. Operating Records. No operating records pertinent to the structural stability of the dam were disclosed.

d. Post-Construction Changes. No records pertinent to post-construction changes were disclosed.

e. Seismic Stability. This dam is located in Seismic Zone 1 and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Lake Estling Dam is 84 years old and is in fair overall condition.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based primarily on the results of the visual inspection.

c. Urgency. The recommendations made in Section 7.2 a. and the operating and maintenance procedures in 7.2 c. should be implemented by the owner as prescribed.

d. Necessity for Additional Data/Evaluation. The information available from the visual inspection is adequate to identify the potential problems which are described in Sections 5 and 6. These problems require the attention of a professional engineer experienced in the design and construction of dams, who will have to make additional engineering studies to design or specify remedial measures. If left unattended, the problems could lead to instability of the structure. The spillway should be inspected when no water is flowing over the crest. Because the spillway is seriously inadequate, additional hydrologic and hydraulic analyses should be performed.

7.2 Recommendations/Remedial Measures

a. Recommendations. The owners should retain the services of a professional engineer experienced in the design and construction of dams to accomplish the following:

(1) Starting immediately conduct further hydrologic and hydraulic analyses of the watershed, reservoir, and dam to better define the capacity of the spillway and conduit beneath the railroad embankment and design and oversee the implementation of mitigating measures necessary to provide for safe passage of high discharges.

(2) Starting immediately investigate the seepage at the downstream toe, and design and implement appropriate remedial measures.

(3) In the near future, design and supervise a program for clearing trees, their root systems, and brush from the upstream and downstream dlopes of the dam.

(4) Starting soon, investigate the location and condition of the low level outlet pipes and valves and, if necessary, design and implement procedures to restore them to an operable condition.

(5) Starting very soon, design repairs for the areas where erosion has occurred on the upstream and downstream slopes of the dam, and provide appropriate slope protection.

(6) In the near future, design and implement repairs for the abutments of the spillway to stop the leakage and to restore the stone masonry to good structural condition.

b. Operating and Maintenance Procedures. The owners should:

(1) Control trespassing on the upstream and downstream slopes of the dam. This should be done soon.

(2) Check the condition of the dam periodically and monitor the seepage until remedial measures are effected. This should be started immediately.

(3) Engage a professional engineer experienced in the design and construction of dams to make a comprehensive technical inspection of the dam once every two years. This should be started in the future.

(4) Establish a surveillance program for use during and immediately following periods of heavy rainfall, and also a warning program to follow in case of floodflow conditions or imminent dam failure. This should be done in the near future.

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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE ESTLING DAM
LOCATION MAP

DEN BROOK NEW JERSEY

SCALE: SEE BAR SCALE

DATE: AUGUST 1979

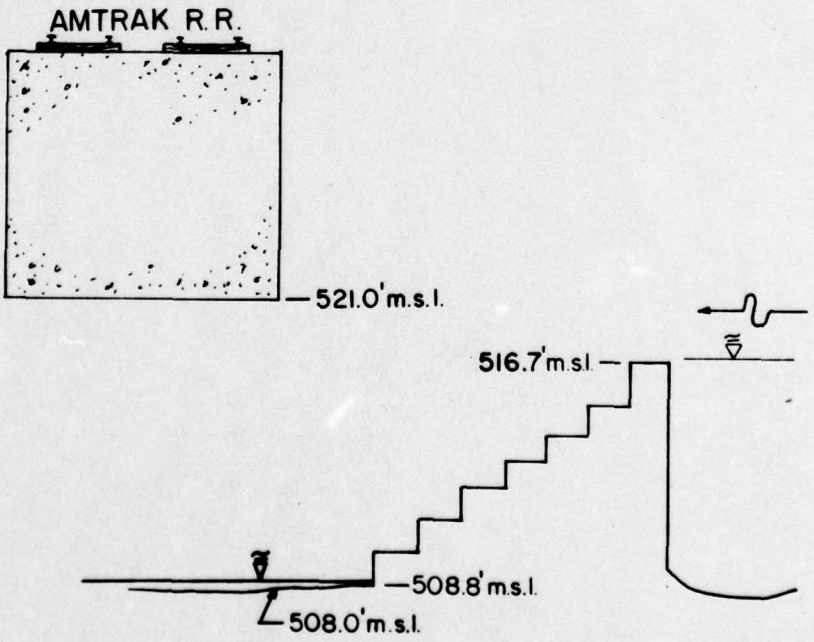
FIGURE 1

SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW JERSEY OFFICIAL HIGHWAY MAP AND GUIDE.

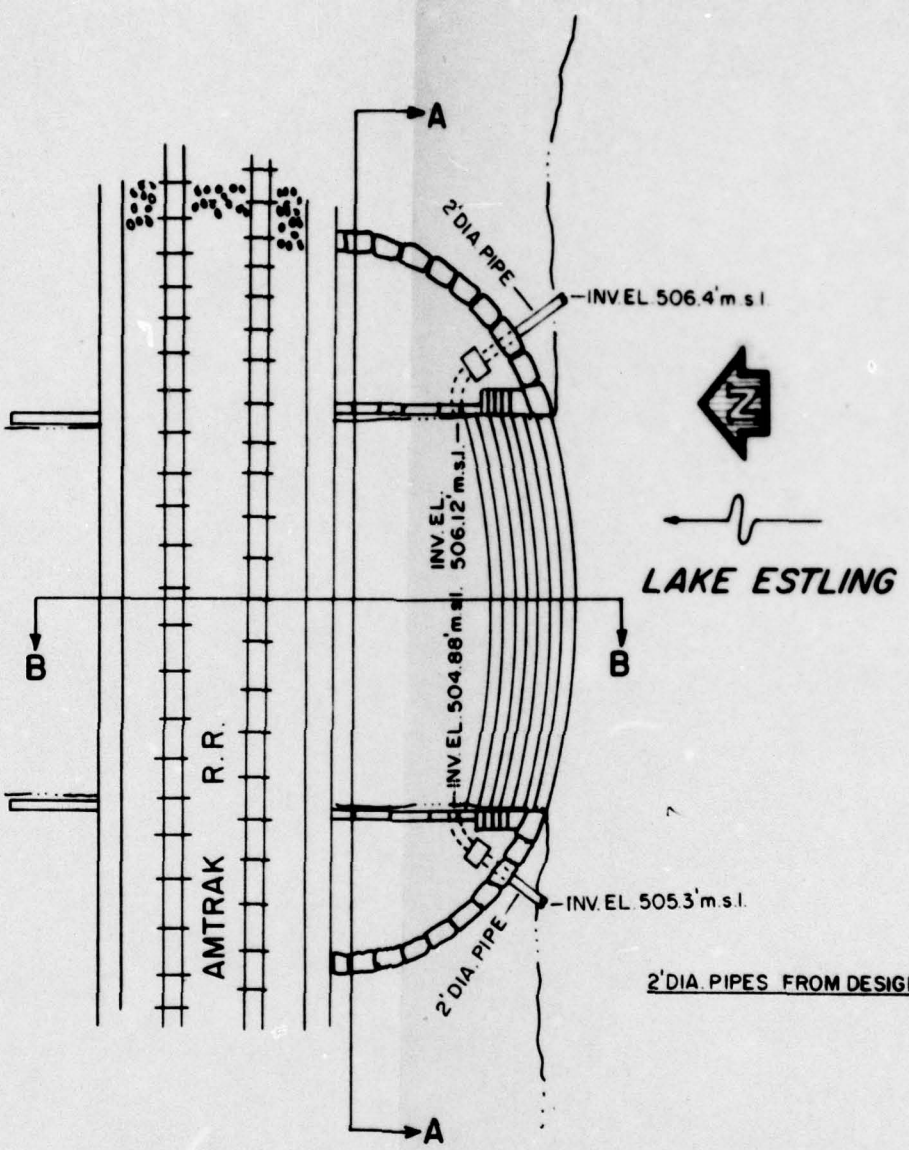
SPILLWAY ELEVATION A-A



SPILLWAY SECTION B-B

EV. 521.0' m.s.l.

08.8' m.s.l.



2' DIA. PIPES FROM DESIGN DRAWINGS.

PLAN

2

DATA FROM FIELD INSPECTION MAY 16, 1979

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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE ESTLING DAM

DEN BROOK NEW JERSEY

SCALE: NOT TO SCALE

DATE: JULY 1979

FIGURE 2

APPENDIX I

VISUAL INSPECTION

CHECKLIST

LAKE ESTLING DAM

Check List
Visual Inspection
Phase 1

Name Dam Estling Lake Dam County Morris State New Jersey Coordinators NJDEP

Date(s) Inspection 5/16/79 Weather Sunny Temperature 65° F

Pool Elevation at Time of Inspection 516.9 MSL Tailwater at Time of Inspection 508.8 MSL

Inspection Personnel:

Warren Guinan	Ronald Hirschfeld
Stephen Gilman	
David Deane	

Gilman & Hirschfeld Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None apparent	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None apparent	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Considerable trespassing and erosion on both upstream and downstream slopes. Railroad on crest.	Control trespassing, repair existing erosion, and design appropriate erosion-control measures.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good	
RIPRAP FAILURES	No riprap	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RAILINGS		
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Trespassing and erosion next to both wingwalls on downstream end of culvert below spillway.	Control trespassing, repair erosion, and design appropriate erosion-control measures.
ANY NOTICEABLE SEEPAGE	Significant seepage and wet spots at downstream toe from right abutment to spillway and from spillway part way to left abutment.	Investigate seepage and design appropriate seepage-control measures.
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	Cut stone masonry	Crest in good condition. Downstream face not visible due to flow over dam.
ABUTMENTS	Mortared stone masonry	Mortar in top joints spalled and deteriorated, some cracking in mortar on vertical faces. Both abutments leaking through 3rd, 4th, and 5th joints from top. Leaking 30 gpm each abutment. Mortar in joint near spillway where in contact with water have completely eroded away.
APPROACH CHANNEL	Wide and unobstructed	
DISCHARGE CHANNEL	Culvert immediately downstream of spillway weir discharges into a short (100 ft) channel and then into Indian Lake.	
BRIDGE AND PIERS OVER SPILLWAY	Railroad bridge downstream of spillway.	Upstream face of railroad bridge has numerous cracks and spalled areas.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER	None observed.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle, wooded.	
SEDIMENTATION	No evidence of significant sedimentation.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Wide and unobstructed (Indian Lake)	
SLOPES	Gentle, wooded	
APPROXIMATE NO. OF HOMES AND POPULATION	Shores of Indian Lake have extensive residential development, 10 homes with an estimated population of 30 are immediately below Estling Lake Dam.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Plan of dam shown in Figure 2 from Visual Inspection on May 16, 1979. No original plans disclosed.
REGIONAL VICINITY MAP	Prepared for this report.
CONSTRUCTION HISTORY	None disclosed.
TYPICAL SECTIONS OF DAM	From visual inspection of May 16, 1979.
HYDROLOGIC/HYDRAULIC DATA	None disclosed.
OUTLETS - PLAN	Details of low-level outlets shown on design plans June 14, 1895.
- DETAILS	Basic dimensions and elevations shown (no gating mechanisms shown).
- CONSTRAINTS	None disclosed.
- DISCHARGE RATINGS	None disclosed.
RAINFALL/RESERVOIR RECORDS	None disclosed.

ITEM		REMARKS
SPILLWAY PLAN		Copies of original retained by owner.
	SECTIONS	Prepared for this report from sketches of original drawings and data from May 16, 1979 field inspection.
	DETAILS	Prepared for this report from sketches of original drawings and data from May 16, 1979 field inspection.
OPERATING EQUIPMENT		None disclosed.
PLANS & DETAILS		None disclosed.

ITEM	REMARKS
DESIGN REPORTS	None disclosed.
GEOLOGY REPORTS	None disclosed.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None disclosed.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None disclosed.
POST-CONSTRUCTION SURVEYS OF DAM	Field Survey May 16, 1979 by study contractor. No other surveys disclosed.
BORROW SOURCES	Unknown

ITEM	REMARKS
MONITORING SERVICES	None disclosed.
MODIFICATIONS	None disclosed.
HIGH POOL RECORDS	None disclosed.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None disclosed.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None disclosed.
MAINTENANCE OPERATION RECORDS	None disclosed.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: gently sloping, heavily wooded, 6.44 sq. miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 516.7'MSL (358 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): not applicable

ELEVATION MAXIMUM DESIGN POOL: 527.7'MSL

ELEVATION TOP DAM: 527.0'MSL

CREST: free overflow curved stepped spillway

a. Elevation 516.7'MSL

b. Type cut masonry stone

c. Width eight steps of 14" rise, crest width=24", total spillway width-11.3'

d. Length 34'

e. Location Spillover not applicable

f. Number and Type of Gates none

OUTLET WORKS: two drawdown pipes

a. Type 24" diameter of unknown material with strainer boxes (from design drawings)

b. Location one each located under left and right abutment

c. Entrance Inverts left pipe: 505.3'MSL, right pipe: 506.4' MSL (from design drawings)

d. Exit Inverts left pipe: 504.9' MSL, right pipe: 505.6' MSL (from design drawings)

e. Emergency Draindown Facilities described above

HYDROMETEORLOGICAL GAGES: none disclosed

a. Type

b. Location

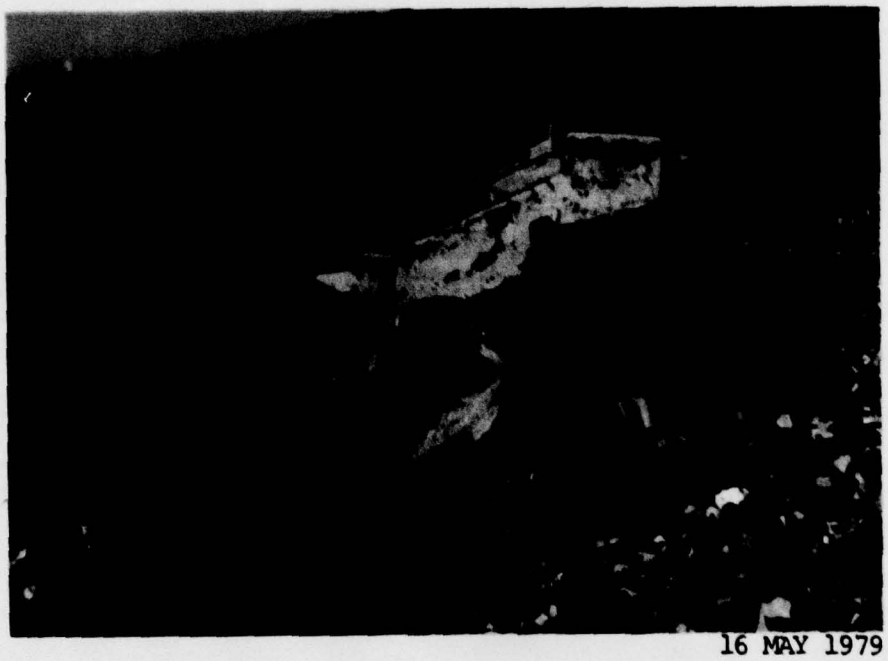
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 5105 cfs

APPENDIX 2

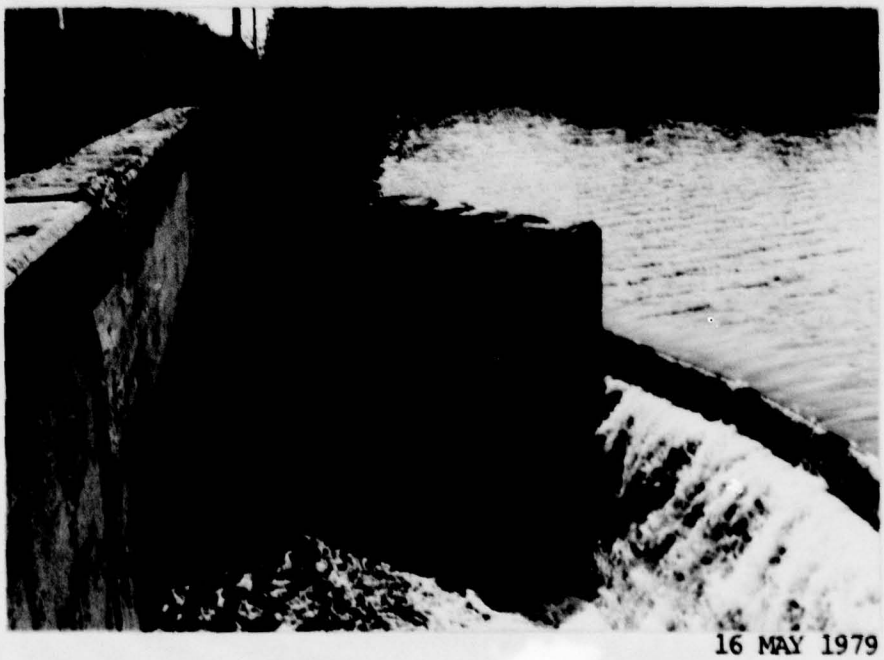
PHOTOGRAPHS

LAKE ESTLING DAM



16 MAY 1979

SPILLWAY AND RAILROAD EMBANKMENT LOOKING WEST



16 MAY 1979

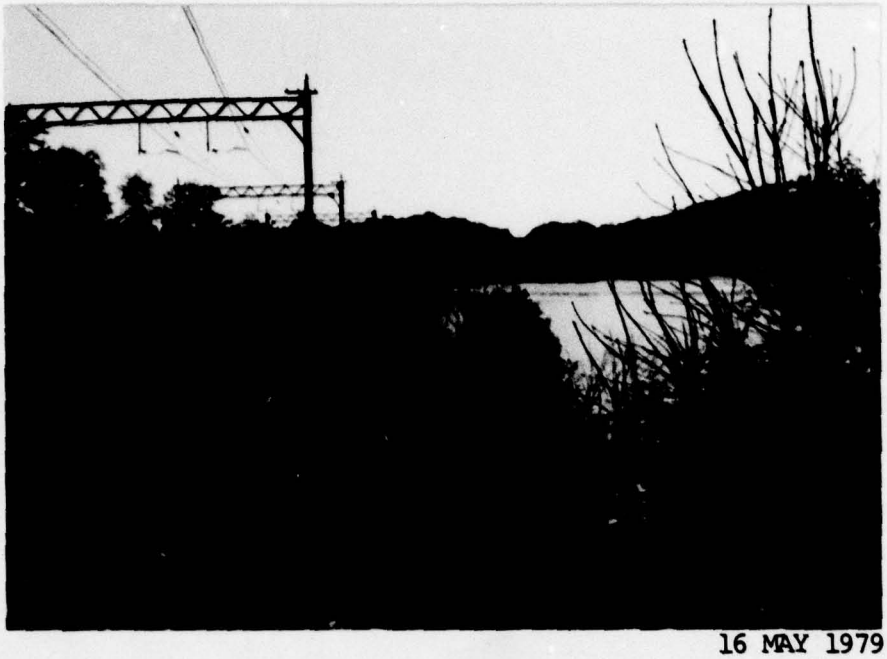
RIGHT ABUTMENT

16 MAY 1979

VIEW OF RAILROAD EMBANKMENT FROM LEFT ABUTMENT LOOKING WEST

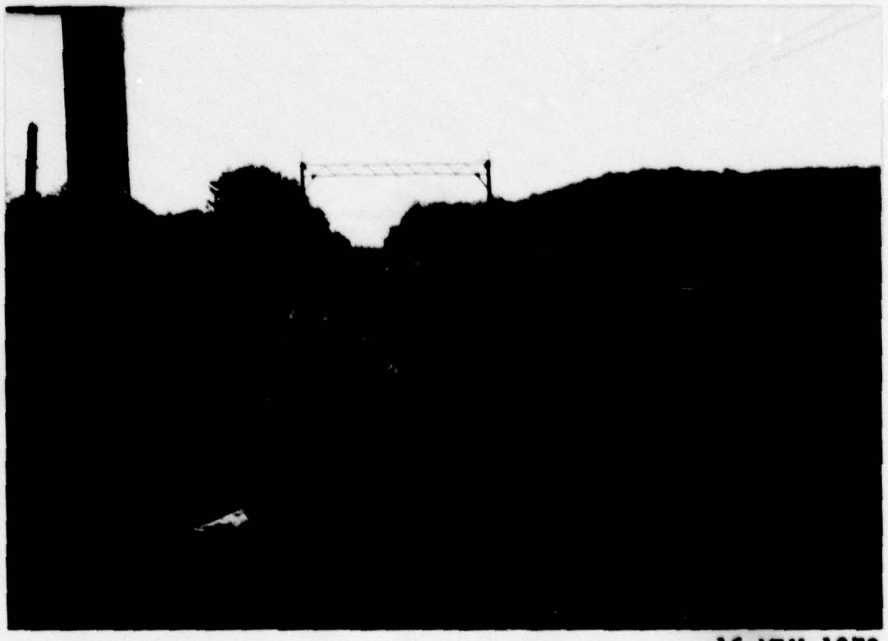
16 MAY 1979

VIEW OF RAILROAD EMBANKMENT FROM RIGHT END OF DAM LOOKING WEST



16 MAY 1979

VIEW OF RAILROAD EMBANKMENT FROM LEFT ABUTMENT LOOKING EAST



16 MAY 1979

VIEW OF RAILROAD EMBANKMENT FROM LEFT END OF DAM LOOKING EAST

16 MAY 1979

SEEPAGE AT RIGHT ABUTMENT

16 MAY 1979

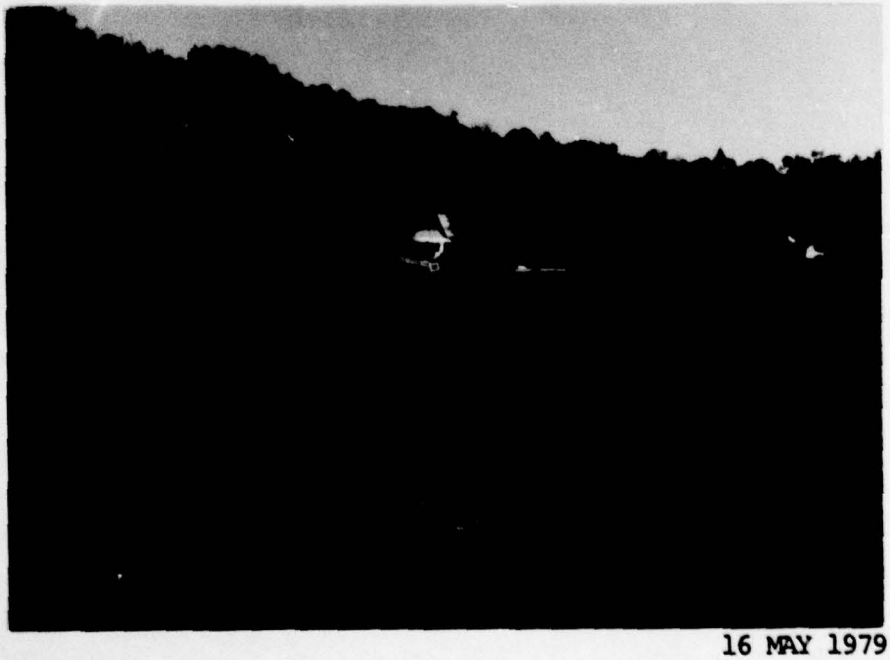
LEFT ABUTMENT

16 MAY 1979

SEEPAGE AT LEFT ABUTMENT

16 MAY 1979

VIEW LOOKING UPSTREAM OVER RAILROAD EMBANKMENT

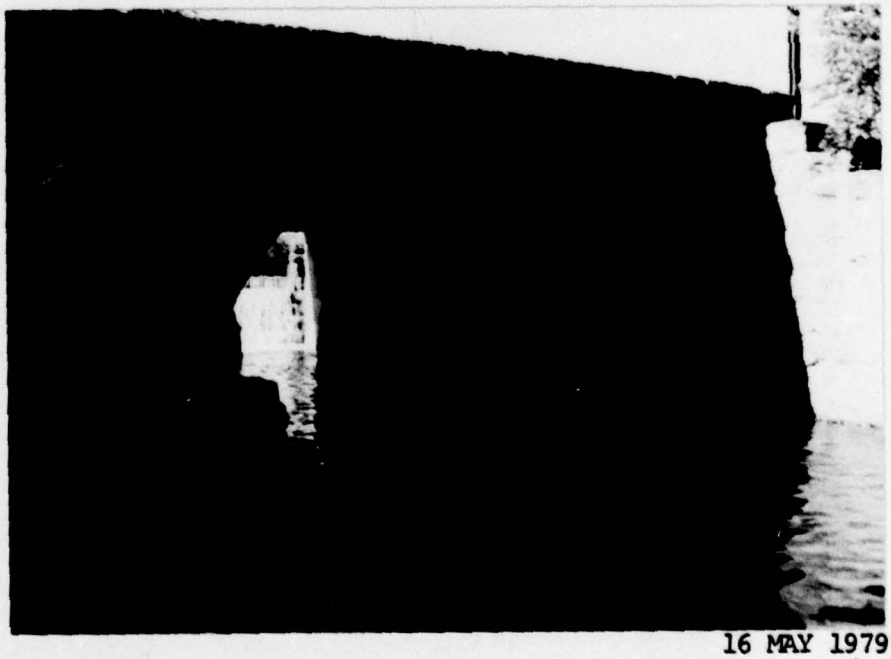


16 MAY 1979

VIEW LOOKING DOWNSTREAM FROM BRIDGE OVER SPILLWAY OUTLET

16 MAY 1979

VIEW OF DOWNSTREAM CULVERT THROUGH RAILROAD EMBANKMENT



16 MAY 1979

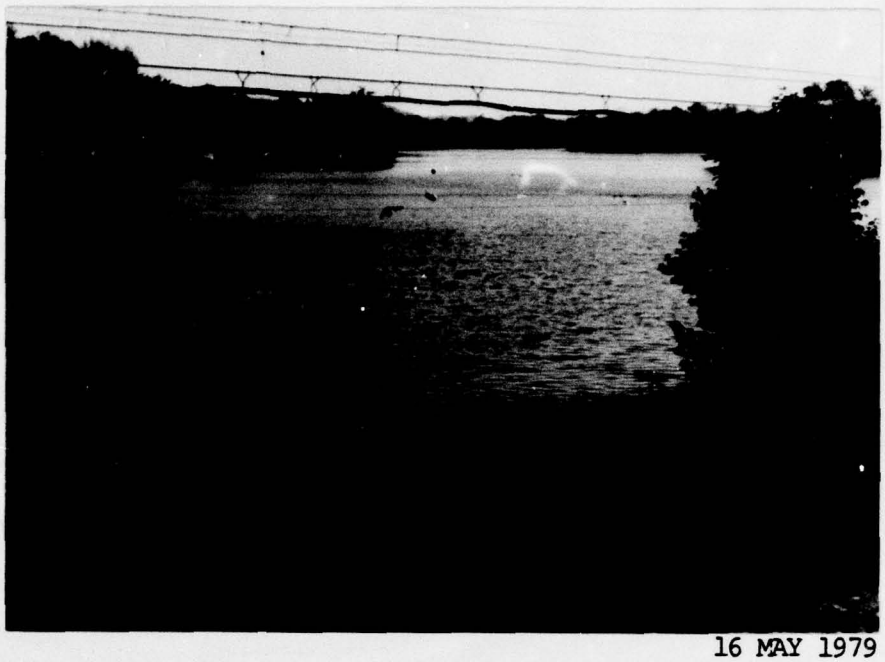
CULVERT THROUGH RAILROAD EMBANKMENT LOOKING UPSTREAM TO SPILLWAY

16 MAY 1979

LOOKING WEST ALONG DOWNSTREAM TOE OF RAILROAD EMBANKMENT SHOWING SOFT, WET AREA AT TOE. INDIAN LAKE AT RIGHT ON PHOTO.

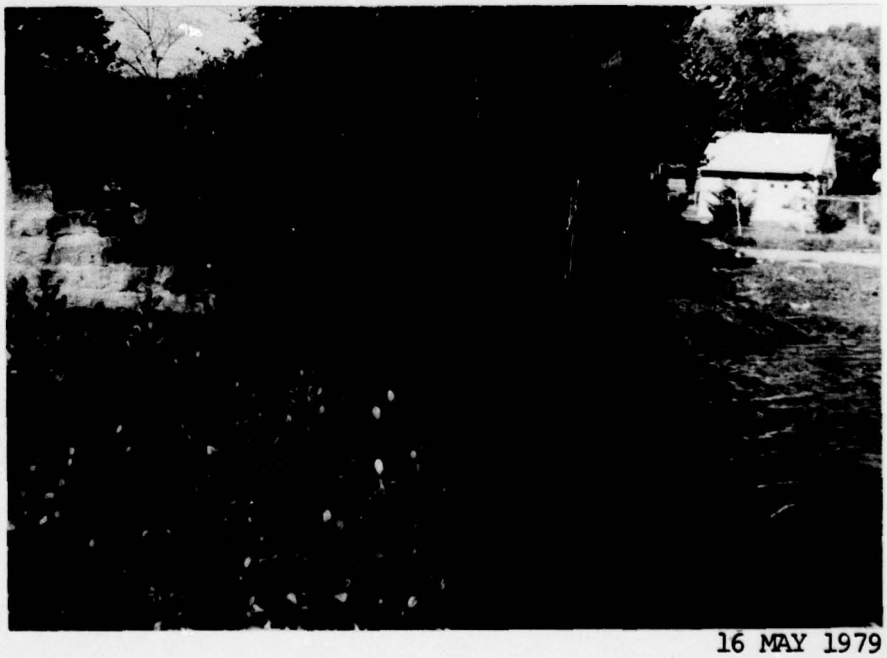
16 MAY 1979

SEEPAGE ALONG DOWNSTREAM TOE OF RAILROAD EMBANKMENT. AREA TO LEFT OF LAKE ESTLING OUTLET.



16 MAY 1979

VIEW LOOKING DOWNSTREAM OF INDIAN LAKE FROM BRIDGE OVER SPILLWAY



16 MAY 1979

RESIDENCE 300 FEET DOWNSTREAM ADJACENT TO LAKE ESTLING OUTLET

APPENDIX 3

HYDROLOGIC COMPUTATIONS

LAKE ESTLING DAM

SQUARES 1/4 IN. SCALE

HYDROLOGIC COMPUTATIONS

NAME: LAKE ESTLING DAM

LOCATION: MORRIS COUNTY, NJ

DRAINAGE AREA: 6.44 SQ. MI.

SURFACE AREA: 75 ACRES

EVALUATION CRITERIA: SIZE: INTERMEDIATE
HAZARD: HIGH

SPILLWAY DESIGN FLOOD: BASED ON SIZE AND HAZARD CLASSIFICATION THE SPILLWAY DESIGN FLOOD WILL BE THE PMF (PROBABLE MAXIMUM FLOOD), WITH A PEAK INFLOW OF 15584 CFS

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

TIME OF CONCENTRATION

DEN BROOK IS THE STREAM DRAINING THE LAKE ESTLING WATERSHED.

FROM THE INDIAN LAKE DAM PHASE I INSPECTION REPORT:

THE GROUND COVER OF THE BASIN IS "FOREST WITH HEAVY GROUND LITTER & MEADOW" CN = 60

$$\text{SLOPE OF DEN BROOK} = \frac{800 - 516}{24000} = 0.0118$$

SLOPE OF OVERLAND FLOW $\cong$ 6.4%

A) OVERLAND FLOW TIME : SEE SCS TR #55 FIGURE 3.1

TIME HIGHEST POINT ON WATERSHED TO STREAM : T_{AB}

$$T_{AB} = \frac{5000}{0.64\,(3600)} = 2.17 \text{ HRS.}$$

STREAM FLOW

ESTIMATED VELOCITY AT STREAM = 6 fps

TIME STREAM THREAD BEGINS TO RESERVOIR = T_{BC}

$$T_{BC} = \frac{24000}{6\,(3600)} = 1.11 \text{ HRS.}$$

$$T_C = T_{AB} + T_{BC} = 2.17 + 1.1 = 3.27$$

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Subject H&H

LAKE ESTLING DAM

Sheet No. 3 of 12
Date 6/79
Computed KWS
Checked EDD

B) DETERMINE T_c BY SCS TR #55 FIGURE 3.3

AVERAGE SLOPE = 3%

L = 20000 FT

∴ LAG TIME = 3.5

$$\therefore T_c = \frac{3.5}{0.6} = 5.8 \text{ HRS.}$$

TAKE $\boxed{T_c = 3.2 \text{ HRS}}$

TIME OF PEAK

$$T_p = \frac{D}{2} + 0.6\,T_c$$

TAKE $D \cong 0.2\,T_c$ ⫶ $0.3\,T_c$

$D = 0.8$ HR

$$T_p = \frac{0.8}{2} + 0.6\,(3.2) = 2.32 \text{ HRS}$$

TAKE $\boxed{T_p = 2.5 \text{ HRS.}}$

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Sheet No. 4 of 12
Date 6/79
Computed KVS
Checked EDD

JOB NO. 3290-12

LAKE ESTLING DAM

SQUARES 1/4 IN. SCALE

STORAGE - ELEVATION DETERMINATIONS

ELEVATION FT	HEAD FT	AREA ACRES	AVG. AREA · ACRES	STORAGE ACRE-FT	TOTAL AC-FT.
516.7	0	75			326
517.7	1	79.5	77	77	403
518.7	2	84	80	159	485
519.7	3	88.5	82	245	571
520.7	4	93.0	84	330	662
522.7	6	102.0	88.5	531	857
524.7	8	111.0	93	744	1070
527.7	11	124.5	99.5	1097	1423
528.7	12	129.0	102.0	1224	1550
530.7	14	138.0	106.5	1491	1817

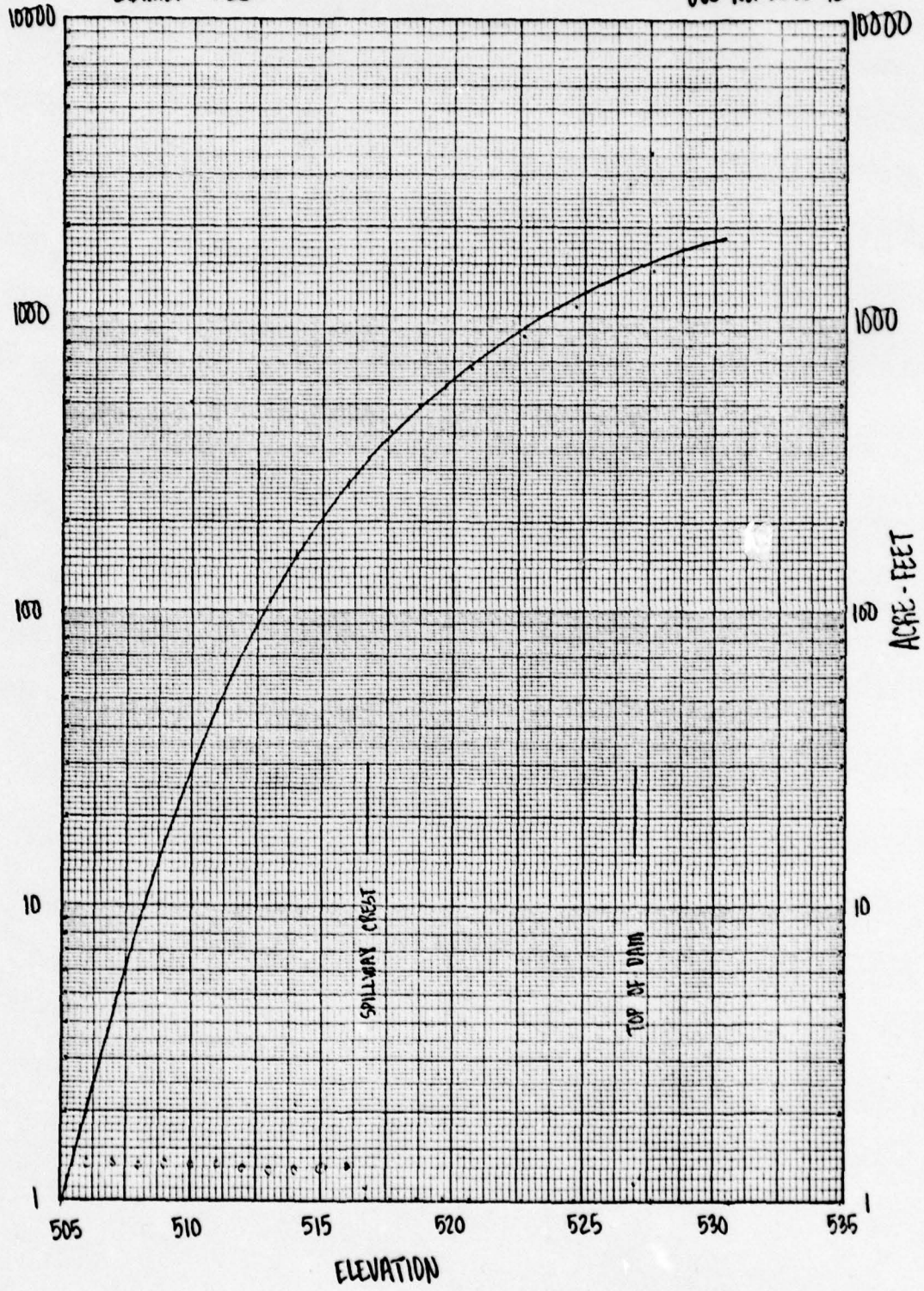
$$\text{STORAGE} = \frac{\text{AREA}_2 - \text{AREA}_1}{2} \cdot \Delta \text{ HEAD}$$

① FROM: INDIAN LAKE DAM INSPECTION REPORT

ANDERSON-NICHOLS & COMPANY

6/79
Computed KJS
Checked FDD

LAKE ESTLING DAM 5/12
STORAGE-ELEVATION
JOB NO. 3270-12



SQUARES 1/4 IN. SCALE

SPILLWAY CAPACITY

① SPILLWAY CURVE

Ⓐ DETERMINE Q USING WEIR EQUATION ($Q = CLH^{3/2}$) TO THE SPILLWAY ABUTMENTS. FOR THIS $C = 3.2$, $L = 34'$.

TO DETERMINE Q ABOVE SPILLWAY ABUTMENTS USE THE VALUES $C = 2.7$ $L = \pi r = 38'$. (ABUTMENT ELEV. = 521.0)

TO DETERMINE Q ABOVE RAILROAD EMBANKMENT USE THE VALUES $C = 3.0$ USE L FROM SKETCH (RAILROAD $ELEV._{AVG.} = 527.0$)

NOTE: C VALUES FROM "HANDBOOK OF HYDRAULICS" KING & BRATER PG. 5-50, TABLE 5-13; PG 5-46, TABLE 5-3; PG. 5-49, TABLE 5.9

② CULVERT

Ⓐ DETERMINE CULVERT CAPACITY USING THE DIMENSIONS

$H = 13'$ $L = 26'$ (INVERT ELEV = 508.0)

NOTE: CAPACITY DETERMINED FROM "OPEN CHANNEL HYDRAULICS" CHOW. PG. 498, FIG. 17-29

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6/79 Computed NJS
Checked FOD

LAKE ESTLING DAM
OUTLET SECTION
JOB NO. 3290-12

7/12

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Subject: HYD

JOB NO. 3290-12

LAKE ESTLING DAM

Sheet No. 8 of 12

Date 4/78

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SQUARES 1/4 IN. SCALE

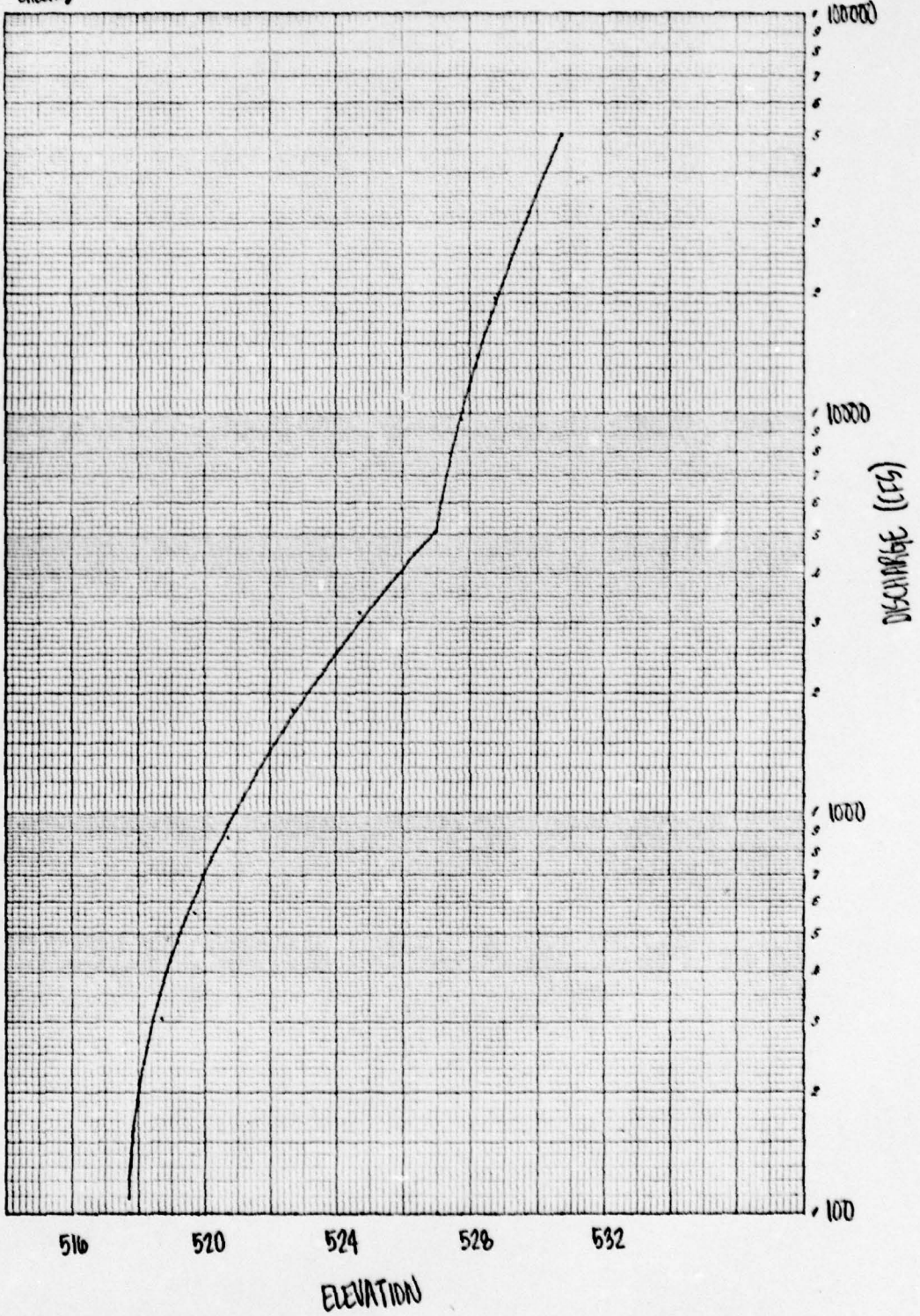
ELEVATION (FEET)	SPILLWAY SECT. A-A TO ABUTMENTS		SPILLWAY SECT. B-B ABOVE ABUTMENTS		SPILLWAY SECT. C-C OVER RAILROAD			CULVERT UNDER RR EMBANKMENT				Q_{TOTAL} $Q_A+Q_B+Q_{RR}=Q_T$ (OR) $Q_C+Q_{RR}=Q_T$ (CFS)
	HEAD (FT)	Q (CFS)	HEAD (FT)	Q (CFS)	H (FT)	L (FT)	Q (CFS	HEAD (FT)	H/d	Q/b	Q_C (CFS)	
516.7	0											0
517.7	1	109										109
518.7	2	308										308
519.7	3	565										565
520.7	4	870										870
522.7	6	1599	1.7	227				14.7	1.13	175	4550	1826
524.7	8	2462	3.7	730				16.7	1.28	200	5200	3192
527.0	10.3	3597	6.0	1508				19.0	1.46	210	5460	5105
527.7	11	3969	6.7	1779	0.7	2000	3514	19.7	1.50	235	6110	9262
528.7	12	4523	7.7	2192	1.7	2000	13300	20.7	1.60	240	6240*	19540
530.7	14	5699	9.7	3100	3.7	2000	42702	22.7	1.75	270	7020*	49722

* CULVERT CONTROLS AT THESE ELEVATIONS

7/79
COMPUTED: KJS
CHECKED: FOO

LAKE ESTLINK
RATING CURVE
JOB NO. 3290-12

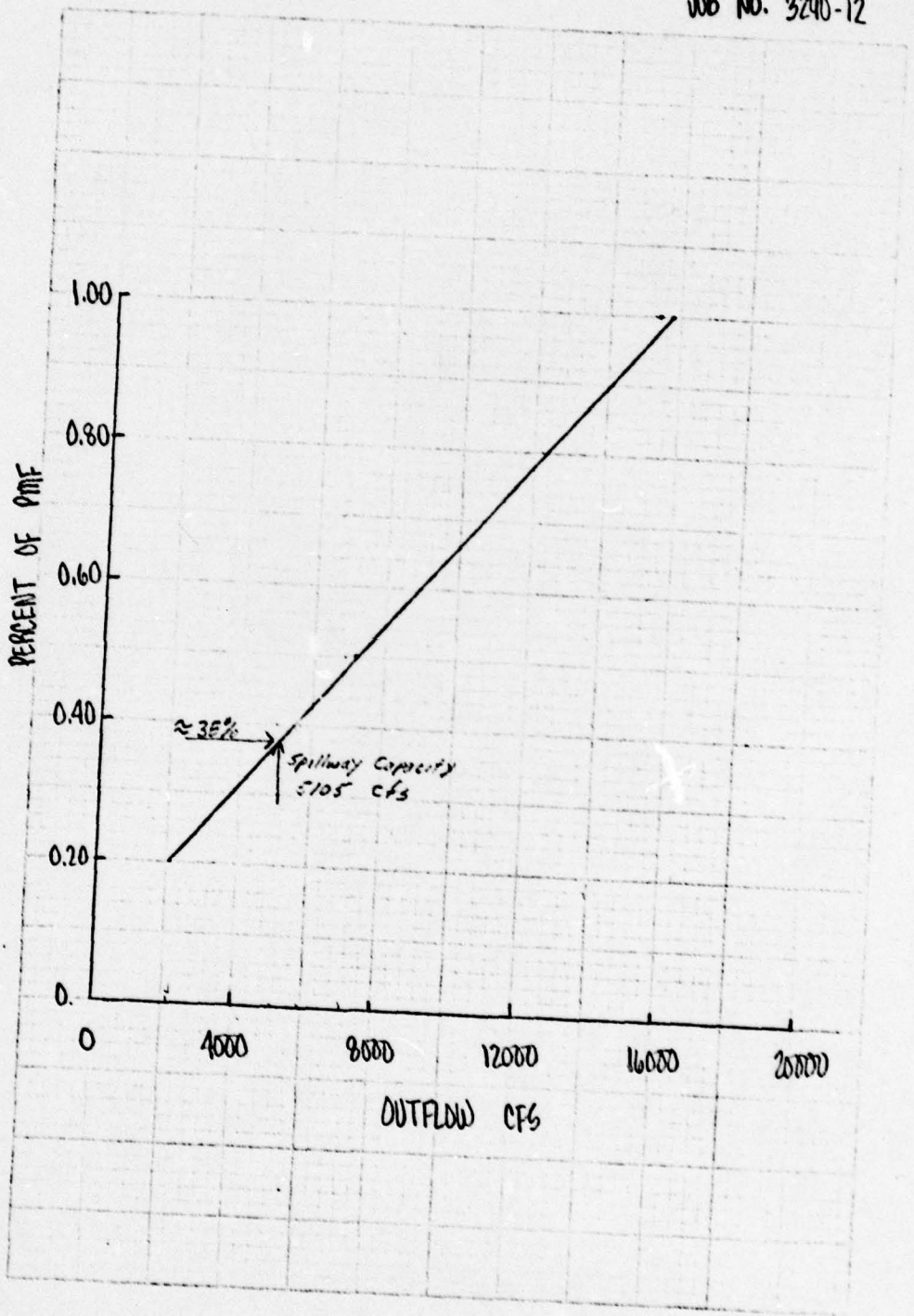
9/12



ANDERSON-NICHOLS & COMPANY
Computed KJS
Checked FOD

LAKE ESTLING DAM
OVERTOPPING POTENTIAL
JOB NO. 3290-12

10/12



Anderson-Nichols & Company, Inc. Subject H&H Sheet No. 11 of 12

JOB NO. 3290-12 LAKE ESTLING DAM Date 8/79 Computed KVS Checked EMD

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

UNIT HYDROGRAPH

TAKE q_p FROM SCS FORMULA

$$q_p = \frac{484\,A}{T_p} = \frac{484\,(6.44)}{2.5} = 1210 \text{ CFS}$$

A CURVILINEAR HYDROGRAPH MAY BE CONSTRUCTED FROM THE VALUES OF q_p & T_p BY USING SCS RATIOS

HOURS D	T/T_p	q/q_p	UNIT HYDROGRAPH q CFS
0.5	.20	.08	97
1.0	.40	.32	387
1.5	.60	.60	726
2.0	.80	.90	1089
2.5	1.0	1.0	1210
3.0	1.2	.92	1113
3.5	1.4	.78	944
4.0	1.6	.60	726
4.5	1.8	.42	508
5.0	2.0	.32	387
5.5	2.2	.24	290
6.0	2.4	.17	205
6.5	2.6	.14	169
7.0	2.8	.10	121
7.5	3.0	.07	85
8.0	3.2	.055	67
8.5	3.4	.04	48
9.0	3.6	.03	36
9.5	3.8	.02	24
10.0	4.0	.018	22
			Σ = 8205 CFS

Anderson-Nichols & Company, Inc.

JOB NO. 3290-12

Subject H&H — LAKE ESTLING DAM

Sheet No. 12 of 12

Date 4/87

Computed EWS

Checked EWS

SQUARES 1/4 IN. SCALE

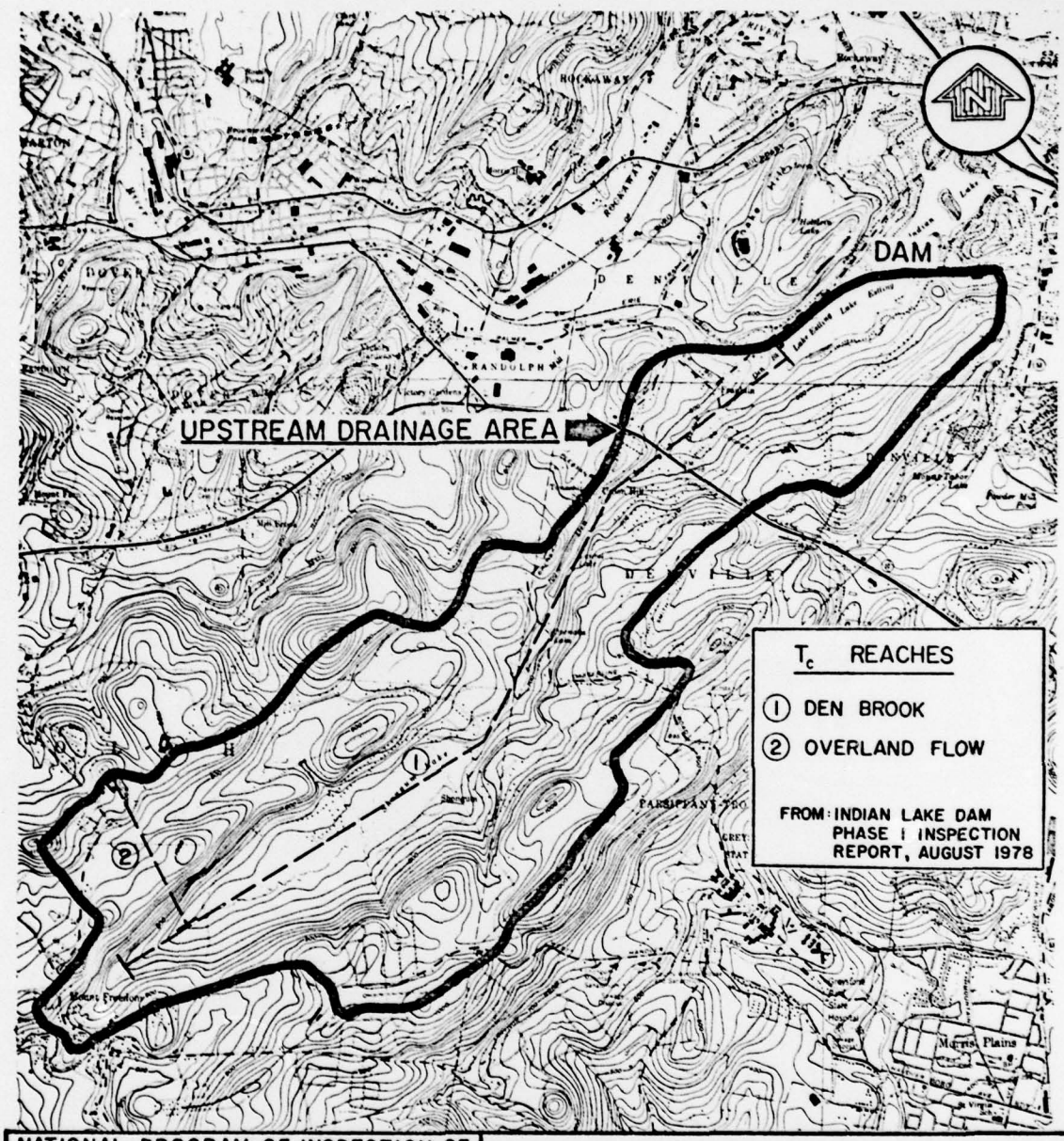
DRAWDOWN CALCULATIONS

CALCULATIONS ASSUME ① NO SIGNIFICANT INFLOW ② TWO 24" C.I. LOW LEVEL OUTLET BE FULLY OPERABLE ③ $Q_p = C_p(H)^{1/2}$ (SEE BELOW) ④ AC./FT./DAY = 1.9835 (AVG. Q) ⑤ DAYS = Δ STORAGE / AC.-FT.-DAY

ELEV. FT.	STORAGE AC.-FT.	Δ STORAGE AC.-FT.	H FT.	Q CFS	AVG. Q	AC-FT/ DAY	DAYS
516.9	326		11.4	107			
		56			105	208	0.27
516.0	270		10.5	103			
		65			100	198	0.33
515.0	205		9.5	98			
		50			96	190	0.26
514.0	155		8.5	93			
		48			90	179	0.27
513.0	107		7.5	87			
		33			84	167	0.20
512.0	74		6.5	81			
		27			78	155	0.17
511.0	47		5.5	75			
		18			71	141	0.13
510.0	29		4.5	67			
		18			63	125	0.14
509.0	11		3.5	59			
		2			54	107	0.02
508.0	9		2.5	50			
		5			45	89	0.06
507.0	4		1.5	40			
		2			31	61	0.03
506.0	2		0.5	23			
		1			12	24	0.04
505.0	1		0	0			

1.92 DAYS

$Q_p = C_p(H^{3/2})$ $\quad C_p = A_p\sqrt{\frac{29}{1+K_L+K_F+L_p}}$ $\quad C_p = 15.9$ $\quad \therefore (2)C_p = 31.8$



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE ESTLING DAM
DENVILLE TOWNSHIP, NEW JERSEY

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

ANDERSON-NICHOLS & CO., INC. BOSTON, MA.

SCALE IN MILES

0 1/2 1 2

MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE SHEETS. MENDHAM, N.J., 1954, UPDATED 1970. MORRISTOWN, N.J., 1954, UPDATED 1970.

HEC-1 OUTPUT

OVERTOPPING AND BREACH ANALYSIS

LAKE ESTLING DAM

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
     1              A1 LAKE ESTLINE DAM OVERTOPPING AND BREACH ANALYSIS.K.STUART.ANDERSON-NICHOLS.
     2              A2 NEW JERSEY DAM NUMBER 34
     3              A3 0.2,0.4,0.5,0.8 AND 1.0 MULTIPLES OF PMF FROM 48-HOUR 22.5 INCH PMP
     4              P    120       0      30       0       0       0       0       0       0       0
     5              B1     5
     6              J      3       3       1
     7              J1   0.2     0.5     1.0
     8              K      0      A1                                               1
     9              K1 DEVELOP INFLOW HYDROGRAPH
    10              K      1      -1    6.99                        .8                          1
    11              P             22.5     112     123     132     142
    12              T                                                       1      .2
    13              U     20
    14              U1    97.     387.    726.   1089.   1210.   1113.    944.    726.    508.    387.
    15              U1   270.     205.    163.    121.     85.     67.     48.     36.     24.     22.
    16              X    -3.
    17              K      1      A2                                               1
    18              K1 ROUTE HYDROGRAPH THROUGH IMPOUNDMENT
    19              Y                                      1       1
    20              Y1     1                                                -516.7      -1
    21              Y4 516.7   517.7   518.7   519.7   520.7   522.7   524.7   527.0   527.7   528.7
    22              Y4 530.7
    23              Y5     0.    109.    308.    565.    870.   1826.   3192.   5105.   9264.  19540.
    24              Y5497224.
    25              1S     0.    403.    485.    571.    662.    857.   1070.   1423.   1550.   1817.
    26              1E 508.8   517.7   518.7   519.7   520.7   522.7   524.7   527.7   528.7   530.7
    27              1S 516.7
    28              1D 527.0
    29              1R    20       1  506.5        1  516.7   527.
    30              1R    10       1  506.5        1  516.7   540.
    31              K     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	A1
ROUTE HYDROGRAPH TO	A2
END OF NETWORK	

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/08/17.
     TIME= 14.45.23.
```

LAKE ESTLING DAM OVERTOPPING AND BREACH ANALYSIS*K.STUART*ANDERSON-NICHOLS*
NEW JERSEY DAM NUMBER 34
0.2*0.4*0.5*0.8 AND 1.0 MULTIPLES OF PMF FROM 48-HOUR 22.5 INCH PMP

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
120	0	30	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 3 NRTIO= 3 LRTIO= 1

RTIOS= .20 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

DEVELOP INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	6.44	0.00	6.44	.80	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.50	112.00	123.00	132.00	142.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSPX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.20	0.00	0.00

GIVEN UNIT GRAPH, NUHGO= 20

97.	387.	726.	1089.	1210.	1113.	944.	726.	508.	387.
290.	265.	169.	121.	85.	67.	48.	36.	24.	22.

UNIT GRAPH TOTALS 8254. CFS OR .29 INCHES OVER THE AREA

RECESSION DATA

STRIO= -3.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

1.01	.30	1	.00	0.00	.00	19.	1.02	6.30	61	.17	.07	.10	26.
1.01	1.00	2	.00	0.00	.00	19.	1.02	7.00	62	.17	.07	.10	51.
1.01	1.30	3	.00	0.00	.00	19.	1.02	7.30	63	.17	.07	.10	98.
1.01	2.00	4	.00	0.00	.00	19.	1.02	8.00	64	.17	.07	.10	169.
1.01	2.30	5	.00	0.00	.00	19.	1.02	8.30	65	.17	.07	.10	247.
1.01	3.00	6	.00	0.00	.00	19.	1.02	9.00	66	.17	.07	.10	320.
1.01	3.30	7	.00	0.00	.00	19.	1.02	9.30	67	.17	.07	.10	381.
1.01	4.00	8	.00	0.00	.00	19.	1.02	10.00	68	.17	.07	.10	428.
1.01	4.30	9	.00	0.00	.00	19.	1.02	10.30	69	.17	.07	.10	461.
1.01	5.00	10	.00	0.00	.00	19.	1.02	11.00	70	.17	.07	.10	486.
1.01	5.30	11	.00	0.00	.00	19.	1.02	11.30	71	.17	.07	.10	505.
1.01	6.00	12	.00	0.00	.00	19.	1.02	12.00	72	.17	.07	.10	519.
1.01	6.30	13	.01	0.00	.01	19.	1.02	12.30	73	1.01	.91	.10	611.
1.01	7.00	14	.01	0.00	.01	19.	1.02	13.00	74	1.01	.91	.10	946.
1.01	7.30	15	.01	0.00	.01	19.	1.02	13.30	75	1.21	1.11	.10	1583.
1.01	8.00	16	.01	0.00	.01	19.	1.02	14.00	76	1.21	1.11	.10	2503.
1.01	8.30	17	.01	0.00	.01	19.	1.02	14.30	77	1.51	1.41	.10	3782.
1.01	9.00	18	.01	0.00	.01	19.	1.02	15.00	78	1.51	1.41	.10	5059.
1.01	9.30	19	.01	0.00	.01	19.	1.02	15.30	79	1.84	1.74	.10	6352.
1.01	10.00	20	.01	0.00	.01	19.	1.02	16.00	80	5.82	5.72	.10	8031.
1.01	10.30	21	.01	0.00	.01	19.	1.02	16.30	81	1.41	1.31	.10	10367.
1.01	11.00	22	.01	0.00	.01	19.	1.02	17.00	82	1.41	1.31	.10	12717.
1.01	11.30	23	.01	0.00	.01	19.	1.02	17.30	83	1.11	1.01	.10	14851.
1.01	12.00	24	.01	0.00	.01	19.	1.02	18.00	84	1.11	1.01	.10	15584.
1.01	12.30	25	.08	0.00	.08	19.	1.02	18.30	85	.08	0.00	.08	15026.
1.01	13.00	26	.08	0.00	.08	19.	1.02	19.00	86	.08	0.00	.08	13655.
1.01	13.30	27	.09	0.00	.09	19.	1.02	19.30	87	.08	0.00	.08	11604.
1.01	14.00	28	.09	0.00	.09	19.	1.02	20.00	88	.08	0.00	.08	9299.
1.01	14.30	29	.11	0.00	.11	19.	1.02	20.30	89	.08	0.00	.08	7298.
1.01	15.00	30	.11	0.00	.11	19.	1.02	21.00	90	.08	0.00	.08	5551.
1.01	15.30	31	.14	0.00	.14	19.	1.02	21.30	91	.08	0.00	.08	4093.
1.01	16.00	32	.44	.27	.17	45.	1.02	22.00	92	.08	0.00	.08	3098.
1.01	16.30	33	.11	.01	.10	123.	1.02	22.30	93	.08	0.00	.08	2282.
1.01	17.00	34	.11	.01	.10	216.	1.02	23.00	94	.08	0.00	.08	1671.
1.01	17.30	35	.08	0.00	.08	317.	1.02	23.30	95	.08	0.00	.08	1243.
1.01	18.00	36	.08	0.00	.08	354.	1.03	0.00	96	.08	0.00	.08	913.
1.01	18.30	37	.01	0.00	.01	332.	1.03	.30	97	0.00	0.00	0.00	657.
1.01	19.00	38	.01	0.00	.01	287.	1.03	1.00	98	0.00	0.00	0.00	458.
1.01	19.30	39	.01	0.00	.01	227.	1.03	1.30	99	0.00	0.00	0.00	340.
1.01	20.00	40	.01	0.00	.01	166.	1.03	2.00	100	0.00	0.00	0.00	164.
1.01	20.30	41	.01	0.00	.01	131.	1.03	2.30	101	0.00	0.00	0.00	109.
1.01	21.00	42	.01	0.00	.01	103.	1.03	3.00	102	0.00	0.00	0.00	66.
1.01	21.30	43	.01	0.00	.01	79.	1.03	3.30	103	0.00	0.00	0.00	42.
1.01	22.00	44	.01	0.00	.01	68.	1.03	4.00	104	0.00	0.00	0.00	19.
1.01	22.30	45	.01	0.00	.01	54.	1.03	4.30	105	0.00	0.00	0.00	19.
1.01	23.00	46	.01	0.00	.01	44.	1.03	5.00	106	0.00	0.00	0.00	19.
1.01	23.30	47	.01	0.00	.01	39.	1.03	5.30	107	0.00	0.00	0.00	19.
1.02	0.00	48	.01	0.00	.01	33.	1.03	6.00	108	0.00	0.00	0.00	19.
1.02	.30	49	.05	0.00	.05	30.	1.03	6.30	109	0.00	0.00	0.00	19.
1.02	1.00	50	.05	0.00	.05	26.	1.03	7.00	110	0.00	0.00	0.00	19.
1.02	1.30	51	.05	0.00	.05	26.	1.03	7.30	111	0.00	0.00	0.00	19.
1.02	2.00	52	.05	0.00	.05	20.	1.03	8.00	112	0.00	0.00	0.00	19.
1.02	2.30	53	.05	0.00	.05	19.	1.03	8.30	113	0.00	0.00	0.00	19.
1.02	3.00	54	.05	0.00	.05	19.	1.03	9.00	114	0.00	0.00	0.00	19.
1.02	3.30	55	.05	0.00	.05	19.	1.03	9.30	115	0.00	0.00	0.00	19.
1.02	4.00	56	.05	0.00	.05	19.	1.03	10.00	116	0.00	0.00	0.00	19.
1.02	4.30	57	.05	0.00	.05	19.	1.03	10.30	117	0.00	0.00	0.00	19.
1.02	5.00	58	.05	0.00	.05	19.	1.03	11.00	118	0.00	0.00	0.00	19.
1.02	5.30	59	.05	0.00	.05	19.	1.03	11.30	119	0.00	0.00	0.00	19.
1.02	6.00	60	.05	0.00	.05	19.	1.03	12.00	120	0.00	0.00	0.00	19.

SUM	25.56	20.02	5.54	167550.	
	(649.)	(509.)	(141.)	(4744.49)	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15584.	10844.	3414.	1396.	167546.
CMS	441.	307.	97.	40.	4744.
INCHES		15.66	19.72	20.17	20.17
MM		397.86	501.00	512.26	512.26
AC-FT		5377.	6771.	6923.	6923.
THOUS CU M		6633.	8352.	8540.	8540.

HYDROGRAPH AT STA A1 FOR PLAN 1, RTIO 3

19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	45.	123.	216.	317.	354.	332.	287.	227.	166.
131.	103.	79.	68.	54.	44.	39.	33.	30.	26.
26.	20.	19.	19.	19.	19.	19.	19.	19.	19.
26.	51.	98.	169.	247.	320.	381.	428.	461.	486.
505.	519.	611.	946.	1503.	2593.	3782.	5059.	6352.	8031.
10367.	12717.	14851.	15584.	15026.	13655.	11644.	9299.	7298.	5551.
4073.	3098.	2282.	1671.	1243.	913.	657.	458.	340.	164.
109.	66.	42.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15584.	10844.	3414.	1396.	167546.
CMS	441.	307.	97.	40.	4744.
INCHES		15.66	19.72	20.17	20.17
MM		397.86	501.00	512.26	512.26
AC-FT		5377.	6771.	6923.	6923.
THOUS CU M		6633.	8352.	8540.	8540.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH IMPOUNDMENT

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A2	1	0	P	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	ASTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-517.	+1

STAGE	516.70	517.70	518.70	519.70	520.70	522.70	524.70	527.00	527.70	528.70
	530.70									
FLOW	0.00	102.00	308.00	565.00	870.00	1826.00	3192.00	5105.00	9264.00	19540.00
	49722.00									
CAPACITY=	0.	403.	485.	571.	662.	857.	1070.	1423.	1550.	1817.
ELEVATION=	509.	518.	519.	520.	521.	523.	525.	528.	529.	531.

OPEL	SPWID	COOW	EXPW	FLEVL	COOL	CAREA	EXPL
516.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
527.0	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBR	TFAIL	WSEL	FAILEL
20.	1.00	506.50	1.00	516.70	527.00

STATION 42, PLAN 1, RATIO 3

BEGIN DAM FAILURE AT 41.00 HOURS

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

2.	3.	5.	7.	8.	9.	10.	11.	11.	12.
13.	13.	14.	14.	15.	15.	16.	16.	16.	17.
17.	17.	17.	18.	18.	18.	18.	18.	18.	18.
18.	20.	26.	39.	61.	87.	111.	130.	142.	147.
148.	145.	139.	133.	126.	119.	111.	104.	97.	91.
85.	79.	73.	68.	63.	59.	55.	52.	49.	46.
44.	44.	46.	55.	69.	89.	114.	142.	171.	200.
228.	255.	285.	337.	445.	643.	1015.	1642.	2542.	3669.
5079.	12149.	15457.	18431.	15486.	14922.	13837.	12257.	10435.	8637.
7054.	5188.	4647.	3761.	2865.	2229.	1769.	1417.	1146.	928.
751.	614.	507.	422.	355.	303.	261.	234.	0.	234.
0.	234.	0.	234.	0.	234.	0.	234.	0.	234.

STORAGE

358.	359.	360.	360.	361.	361.	362.	362.	362.	363.
363.	363.	364.	364.	364.	364.	364.	364.	365.	365.
365.	365.	365.	365.	365.	365.	365.	365.	365.	365.
365.	366.	368.	374.	383.	394.	404.	412.	417.	419.
419.	418.	416.	413.	410.	407.	404.	401.	398.	395.
393.	390.	388.	386.	384.	382.	381.	379.	378.	377.
376.	376.	377.	380.	386.	395.	405.	417.	428.	440.
452.	463.	475.	495.	531.	594.	692.	819.	969.	1138.
1337.	1458.	1458.	1391.	1341.	1305.	1234.	1127.	1001.	873.
748.	633.	530.	438.	361.	301.	250.	208.	171.	139.
110.	85.	69.	96.	31.	18.	7.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STAGE

516.7	516.7	516.7	516.8	516.8	516.8	516.8	516.8	516.8	516.8
516.8	516.8	516.8	516.8	516.8	516.8	516.8	516.8	516.9	516.9
516.9	516.9	516.9	516.9	516.9	516.9	516.9	516.9	516.9	516.9
516.9	516.9	516.9	517.1	517.3	517.5	517.7	517.8	517.9	517.9
517.9	517.9	517.9	517.8	517.8	517.7	517.7	517.7	517.6	517.5
517.5	517.4	517.4	517.3	517.3	517.2	517.2	517.2	517.1	517.1
517.1	517.1	517.1	517.2	517.3	517.5	517.7	517.9	518.0	518.2
518.3	518.4	518.6	518.8	519.2	520.0	521.0	522.3	523.7	525.2
527.0	528.0	528.0	527.4	527.0	526.7	526.1	525.2	524.1	522.8
521.6	520.4	519.2	518.1	516.8	515.4	514.3	513.4	512.6	511.9
511.2	510.7	510.2	509.8	509.5	509.2	509.0	508.8	508.8	508.8
508.8	508.8	508.8	508.8	508.8	508.8	508.8	508.8	508.8	508.8

PEAK OUTFLOW IS 18431. AT TIME 42.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18431.	11603.	3625.	1483.	177015.
CMS	522.	329.	103.	42.	5041.
INCHES		16.76	20.94	21.43	21.43
MM		425.71	531.98	544.27	544.27
AC-FT		5758.	7198.	7356.	7356.
THOUS CU M		7097.	8869.	9073.	9073.

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .020 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .500 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

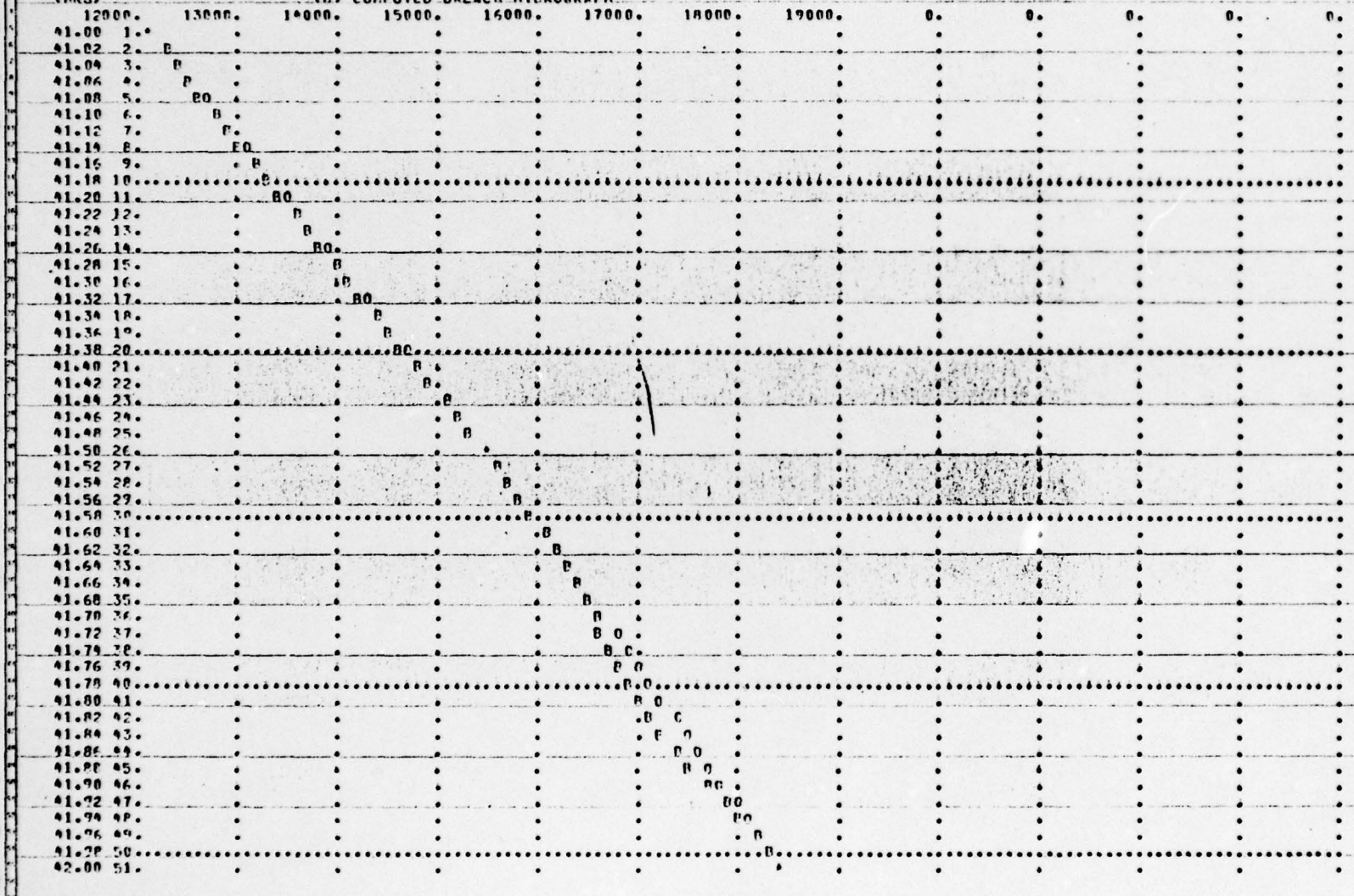
TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	- COMPUTED BREACH HYDROGRAPH (CFS)	= ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
41.000	0.000	12149.	12149.	0.	0.	0.
41.020	.020	12282.	12268.	14.	14.	0.
41.040	.040	12414.	12391.	23.	37.	0.
41.060	.060	12546.	12516.	30.	66.	0.
41.080	.080	12678.	12644.	34.	101.	0.
41.100	.100	12811.	12773.	37.	138.	0.
41.120	.120	12943.	12904.	39.	177.	0.
41.140	.140	13075.	13035.	40.	217.	0.
41.160	.160	13208.	13168.	40.	257.	0.
41.180	.180	13340.	13300.	40.	297.	0.
41.200	.200	13472.	13434.	39.	336.	1.
41.220	.220	13605.	13567.	37.	373.	1.
41.240	.240	13737.	13701.	36.	408.	1.
41.260	.260	13869.	13836.	34.	442.	1.
41.280	.280	14001.	13970.	32.	473.	1.
41.300	.300	14134.	14104.	29.	503.	1.
41.320	.320	14266.	14239.	27.	530.	1.
41.340	.340	14398.	14374.	24.	554.	1.
41.360	.360	14531.	14509.	22.	576.	1.
41.380	.380	14663.	14644.	19.	594.	1.
41.400	.400	14795.	14779.	16.	610.	1.
41.420	.420	14928.	14915.	13.	623.	1.
41.440	.440	15060.	15050.	10.	633.	1.
41.460	.460	15192.	15186.	7.	640.	1.
41.480	.480	15324.	15321.	3.	643.	1.
41.500	.500	15457.	15457.	0.	643.	1.
41.520	.520	15576.	15589.	-13.	630.	1.
41.540	.540	15695.	15714.	-19.	611.	1.
41.560	.560	15814.	15834.	-20.	591.	1.
41.580	.580	15933.	15948.	-15.	576.	1.
41.600	.600	16052.	16057.	-6.	570.	1.
41.620	.620	16171.	16163.	7.	578.	1.
41.640	.640	16290.	16266.	24.	602.	1.
41.660	.660	16409.	16365.	44.	645.	1.
41.680	.680	16528.	16462.	66.	711.	1.
41.700	.700	16646.	16556.	90.	801.	1.
41.720	.720	16765.	16649.	116.	917.	2.
41.740	.740	16884.	16740.	144.	1061.	2.
41.760	.760	17003.	16830.	174.	1235.	2.
41.780	.780	17122.	16918.	204.	1439.	2.
41.800	.800	17241.	17005.	236.	1675.	3.
41.820	.820	17360.	17092.	268.	1943.	3.
41.840	.840	17479.	17203.	277.	2220.	4.
41.860	.860	17598.	17374.	224.	2444.	4.
41.880	.880	17717.	17540.	177.	2621.	4.
41.900	.900	17836.	17700.	136.	2757.	5.
41.920	.920	17955.	17855.	100.	2857.	5.
41.940	.940	18074.	18005.	69.	2926.	5.
41.960	.960	18193.	18151.	42.	2968.	5.
41.980	.980	18312.	18293.	19.	2988.	5.
42.000	1.000	18431.	18431.	0.	2988.	5.

•OVF•

STATION A2

TIME (HRS)

(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(+) POINTS AT NORMAL TIME INTERVAL



DAM BREACH DATA

DRWID	Z	ELBM	TRAIL	WSEL	FAILEL
10.	1.00	506.50	1.00	516.70	540.00

STATION A2, PLAN 2, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

2.	3.	5.	6.	8.	9.	10.	11.	11.	12.
13.	13.	14.	14.	15.	15.	16.	16.	16.	17.
17.	17.	17.	18.	18.	18.	18.	18.	18.	18.
18.	20.	26.	39.	61.	87.	111.	130.	142.	147.
148.	145.	139.	133.	126.	119.	111.	104.	97.	91.
85.	79.	73.	68.	63.	59.	55.	52.	49.	46.
44.	44.	46.	55.	69.	89.	114.	142.	171.	200.
228.	255.	285.	337.	445.	643.	1015.	1642.	2542.	3669.
5079.	12126.	14200.	15473.	15268.	14107.	12283.	10016.	8124.	6388.
5026.	4662.	4159.	3603.	3067.	2602.	2177.	1804.	1546.	1308.
1092.	907.	786.	688.	601.	530.	471.	418.	372.	331.
297.	270.	246.	225.	205.	187.	171.	157.	144.	132.

STORAGE

358.	359.	360.	360.	361.	361.	362.	362.	362.	363.
363.	363.	364.	364.	364.	364.	364.	364.	365.	365.
365.	365.	365.	365.	365.	365.	365.	365.	365.	365.
365.	366.	368.	374.	383.	394.	404.	412.	417.	419.
419.	418.	416.	413.	410.	407.	404.	401.	398.	395.
393.	390.	388.	386.	384.	382.	381.	379.	378.	377.
376.	376.	377.	380.	386.	395.	405.	417.	428.	440.
452.	463.	475.	485.	531.	594.	692.	819.	969.	1138.
1337.	1458.	1484.	1500.	1497.	1483.	1460.	1432.	1400.	1366.
1329.	1278.	1207.	1120.	1051.	978.	912.	853.	800.	751.
707.	670.	637.	608.	582.	559.	539.	522.	506.	493.
480.	470.	460.	451.	443.	435.	429.	423.	417.	412.

STAGE

516.7	516.7	516.7	516.8	516.8	516.8	516.8	516.8	516.8	516.8
516.8	516.8	516.8	516.8	516.8	516.8	516.8	516.8	516.9	516.9
516.9	516.9	516.9	516.9	516.9	516.9	516.9	516.9	516.9	516.9
516.9	516.9	516.9	517.1	517.3	517.5	517.7	517.8	517.9	517.9
517.9	517.9	517.9	517.8	517.8	517.7	517.7	517.7	517.6	517.5
517.5	517.4	517.4	517.3	517.3	517.2	517.2	517.2	517.1	517.1
517.1	517.1	517.1	517.2	517.3	517.5	517.7	517.9	518.0	518.2
518.3	518.4	518.6	518.8	519.2	520.0	521.0	522.3	523.7	525.3
527.0	528.0	528.2	528.3	528.3	528.2	528.0	527.8	527.5	527.2
526.9	526.5	525.9	525.2	524.5	523.8	523.2	522.7	522.1	521.6
521.2	520.8	520.4	520.1	519.8	519.6	519.3	519.1	518.9	518.8
518.6	518.5	518.4	518.3	518.2	518.1	518.0	517.9	517.9	517.8

PEAK OUTFLOW IS 15473. AT TIME 42.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15473.	10191.	3377.	1385.	166246.
CMS	438.	289.	96.	39.	4708.
INCHES		14.72	19.51	20.01	20.01
MM		373.90	495.54	508.29	508.29
AC-FT		5053.	6697.	6870.	6870.
THOUS CU M		6233.	8261.	8474.	8474.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .50	RATIO 3 1.00
HYDROGRAPH AT	A1	6.44	1	3117.	7792.	15584.
	(	16.68)	(	88.26)(	220.65)(	441.29)(
			2	3117.	7792.	15584.
			(	88.26)(	220.65)(	441.29)(
			3	3117.	7792.	15584.
			(	88.26)(	220.65)(	441.29)(
ROUTED TO	A2	6.44	1	2160.	13001.	18431.
	(	16.68)	(	61.17)(	368.14)(	521.91)(
			2	2160.	7166.	15473.
			(	61.17)(	202.93)(	438.15)(
			3	2160.	7166.	15473.
			(	61.17)(	202.93)(	438.15)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	516.70	516.70	527.00
STORAGE	358.	358.	1341.
OUTFLOW	0.	0.	5105.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	523.19	0.00	909.	2160.	0.00	43.50	0.00
.50	527.34	.34	1380.	13001.	1.06	43.50	42.50
1.00	528.02	1.02	1464.	18431.	2.00	42.00	41.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	516.70	516.70	527.00
STORAGE	358.	358.	1341.
OUTFLOW	0.	0.	5105.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	523.19	0.00	909.	2160.	0.00	43.50	0.00
.50	527.35	.35	1381.	7166.	2.00	43.00	0.00
1.00	528.30	1.30	1500.	15473.	4.50	42.00	0.00

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	516.70	516.70	527.00
STORAGE	358.	358.	1341.
OUTFLOW	0.	0.	5105.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	523.19	0.00	909.	2160.	0.00	43.50	0.00
.50	527.35	.35	1381.	7166.	2.00	43.00	0.00
1.00	528.30	1.30	1500.	15473.	4.50	42.00	0.00

APPENDIX 4

REFERENCES

LAKE ESTLING DAM

APPENDIX 4

REFERENCES

LAKE ESTLING DAM

1. Design Plans, Lake Estling Spillway, Lake Estling Ice Company, Scale 1"=4', Denville, N.J., June 14, 1895.

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